FINAL

REMEDIAL INVESTIGATION REPORT FOR THE VASQUEZ-BOULEVARD AND I-70 SUPERFUND SITE OPERABLE UNIT 03 (ARGO SMELTER) DENVER, COLORADO

September 2007

Prepared for, and with oversight by:

U.S. Environmental Protection Agency
Region 8
Denver, Colorado

With Technical Assistance From:

Knight Piésold and Co.
1050 17th Street, Suite 450
Denver, CO 80265

and

Syracuse Research Corporation
999 18th Street, Suite 1975
Denver, CO 80202

FINAL

REMEDIAL INVESTIGATION REPORT FOR THE VASQUEZ-BOULEVARD AND I-70 SUPERFUND SITE OPERABLE UNIT 03 (ARGO SMELTER) DENVER, COLORADO

September 2007

Prepared for, and with oversight by:

U.S. Environmental Protection Agency
Region 8
Denver, Colorado

With Technical Assistance From:

Knight Piésold and Co.
1050 17th Street, Suite 450
Denver, CO 80265

and

Syracuse Research Corporation
999 18th Street, Suite 1975
Denver, CO 80202

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
CDPHE	Colorado Department of Public Health and the Environment
CDC	Center for Disease Control
COPC	Chemical of Potential Concern
CTE	Central Tendency Exposure
CVAA	Cold Vapor Atomic Absorption
DI	Daily Intake
Eco-SSLs	Ecological Soil Screening Levels
EPC	Exposure Point Concentration
°F	Degrees Fahrenheit
FS	Feasibility Study
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
ICP/AES	Inductively Coupled Plasma/Atomic Emission Spectroscopy
ICP/MS	Inductively Coupled Plasma/Mass Spectroscopy
IEUBK	Integrated Exposure Uptake Biokinetic
IRIS	Integrated Risk Information System
LCS	Laboratory Control Sample
MB	Method Blank
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MW	Monitoring Well
NCEA	National Center for Environmental Assessment
NHANES	National Health and Nutrition Evaluation Survey
OERR	Office of Emergency and Remedial Response
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
OVA	Organic Vapor Analyzer
P10	Probability of having a blood lead concentration that exceeds 10 g/dL
PARCC	Precision, Accuracy, Representativeness, Comparability, Completeness
PbB	Concentration of lead (Pb) in Blood
PE	Performance Evaluation
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBC	Risk Based Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure

RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SB	Soil Boring
SF	Slope Factor
TAL	Total Analyte List
TRV	Toxicity Reference Value
STL	Severn Trent Laboratories
TAL	Target Analyte List
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
VBI70	Vasquez Boulevard and Interstate 70
WOE	Weight of Evidence

1.0 INTRODUCTION

1.1 OVERVIEW

The Vasquez Boulevard and Interstate 70 (VBI70) Superfund Site is located in the north-central portion of Denver, Colorado, near the intersection of Interstate 70 and Vasquez Boulevard. As shown in Figure 1-1, three major smelters have operated in the vicinity of the VBI70 site, including the Argo Smelter, the Omaha and Grant Smelter, and the ASARCO Globe Smelter. The VBI70 site consists of three operable units (OUs):

- Operable Unit 1 (OU1) - Off-facility soils (residential soils)
- Operable Unit 2 (OU2) - Omaha and Grant Smelter on-facility soils
- Operable Unit 3 (OU3) - Argo Smelter on-facility soils.

Figure 1-2 shows the boundary of the property previously occupied by the Argo Smelter, which lies between 48th Avenue on the north, 46th Avenue on the south, Broadway Street on the East, and Huron Street on the West. This area constitutes VBI70 OU3.

Operable unit 3 is of potential concern to EPA because smelter operations are often associated with the release of inorganic contaminants to the environment that can be toxic to humans or ecological receptors if environmental levels become high enough. The purpose of this report is to describe investigations and assessments performed by EPA at the site to evaluate the nature and extent of contamination and to assess the potential risks to humans and the environment posed by site-related chemicals. This information will be used by EPA to determine if remedial actions may be necessary to protect human health and the environment from environmental contamination that may have occurred as a result of former smelter operations at this operable unit.

1.2 REPORT ORGANIZATION

In addition to this introduction, this report is organized into the following sections:

Section 2 This section provides a description of the physical setting of the site, including a description of current and anticipated future land use.

Section 3 This section summarizes the soil and groundwater sampling activities of the Phase I Investigation at the site and an assessment of the quality of the data collected.

Section 4 This section summarizes soil and groundwater conditions at the site along with data on the nature and extent of soil and groundwater contamination, based on the results of the Phase I Investigation.

Section 5 This section provides a discussion of the anticipated fate and transport of contaminants detected at the site.

Section 6 This section summarizes the approach and findings of the Baseline Human Health and Screening Level Ecological Risk Assessment for the VBI70 OU3 Site.

Section 7 This section presents a summary of the findings of the Remedial Investigation for the site, including the nature and extent of contamination, anticipated fate and transport of contaminants and conclusions regarding risks to human and ecological receptors.

Section 8 This section provides full citations for USEPA guidance documents, site-related documents, and scientific publications referenced in the RI.

2.0 SITE DESCRIPTION

2.1 SITE HISTORY

The Argo Smelter was owned by the Boston and Colorado Smelting Company and operated during the period of 1878 to 1907. The smelter was built to treat refractory ores to produce gold, silver, and copper. Its operations included roasting, smelting, and refining. A unique process of extracting gold and silver was adopted by Argo that used copper, instead of lead, to extract the metals from the ore. The smelting and refining capacity of the former Argo Smelter was around eighty tons per day (CDPHE 1992). In 1906 a fire destroyed the refinery at the smelter, after which, the smelter ceased refining operations. As copper ores became more scarce, and the mining boom in the state diminished, the smelter closed in 1910 (Klodt 1952).

Solid waste disposal practices at the former Argo Smelter during operation are not known, but it is likely that some wastes were disposed of onsite. Potential wastes and/or hazardous substances associated with past operations at the former Argo Smelter include: metal ores, slag, sulfuric acid, coal ash, sulfates of iron, copper, silver, and lead (CDPHE 1992).

2.2 CURRENT LAND USE

The current land use in the location of the former Argo property is commercial. The ground is now largely covered by highways, building structures, and paved parking lots. Grassy areas are rare and are mainly restricted to highway margins. The land use surrounding the former Argo property is mainly commercial, interspersed with some private residences to the east, south and southwest. This pattern of land use is not expected to change within the foreseeable future.

2.3 REGIONAL TOPOGRAPHY

The VBI70 OU3 Site is located on a bedrock terrace west of the Platte River floodplain. The topography of the site is largely flat, sloping gently toward the Platte River, which flows in a

northeasterly direction. The Platte River is the only major surface water body located in the vicinity of the site.

Other dominant features at the site include two major interstates (Interstate 70 and Interstate 25) and their elevated interchange, a railroad spur (located to the west of the site), and a single rail line located just south of 48th Avenue. The location of these features are shown in Figure 1-2.

2.4 REGIONAL GEOLOGY

Detailed information on the geology in the area of the site is described in Robson and Romero (1981), Robson (1996), and in the preliminary assessment for the site (CDPHE 1992). Information derived from these sources is summarized below.

The VBI70 OU3 site is located east of the Front Range of the Southern Rocky Mountains. The sedimentary rocks underlying the region are known as the Denver Basin, an asymmetric, north-south trending structural basin. At its deepest point, the Denver Basin is more than 13,000 feet thick. The uppermost bedrock formation below the site is the Denver Formation, consisting of inter-bedded claystone and shale (typically about 70%), and siltstone with silty sandstone lenses (typically about 30%) (CDPHE 1992).

There are four formations that underlie the Denver Formation: the Arapahoe Formation, the Laramie Formation, the Fox Hills Sandstone, and the Pierre Shale Formation. The Arapahoe Formation underlies the Denver Formation at a depth of approximately 220 feet below the site and consists of conglomerate sandstone and siltstone (approximately 40%) and shale (approximately 60%). It is the shallowest bedrock aquifer of significant yield in the site area. The Laramie Formation and Fox Hills Sandstone underlie the Arapahoe Formation at depths of approximately 700 feet and 1000 feet, respectively. Underlying the Fox Hills Sandstone is the extensive Pierre Shale Formation, which is considered as the base of the Denver Basin aquifer system, because of its low permeability and thickness of up to 8000 feet (CDPHE 1992).

Unconsolidated sediments, comprised of alluvium, colluvium, and eolian deposits overlie most of the bedrock in the Denver area. The thickness of the unconsolidated sediments is generally less than 20 feet. However, there are some areas within the Denver Basin where the thickness of

unconsolidated sediments exceeds either 80 to 100 feet. Bedrock outcrops are prevalent, and one outcrop is located at the VBI70 OU3 site, underlying the I-70/I-25 Interchange. Sediment thickness in outcrop areas commonly ranges from zero to a few feet (Robson 1996). Figure 2-1 illustrates the estimated thickness of unconsolidated sediments overlying the bedrock in the vicinity of the VBI70 OU3 Site.

There are three distinct physiographic landforms within a mile of the VBI70 OU3 site: an upland surface, the flood plain of the South Platte River, and a terrace escarpment. The former Argo smelter is located on the uplands, near the terrace escarpment, to the west of the South Platte River floodplain.

Soils in the upland area are expected to consist of the Vona sandy loam, Truckton loamy sand, Truckton sandy loam and the Nunn clay loam. The Vona and Truckton series are deep, well to excessively drained coarse-textured soils. The Nunn clay loam is a deep, well drained clayey soil. The upland is separated from the South Platte floodplain by an escarpment that is mapped as a gravelly shale outcrop. These escarpments have steep slopes and very shallow soils over clay, gravel, sale and sandstone (CDPHE 1992).

2.5 REGIONAL HYDROGEOLOGY

Information on the regional hydrogeology in the area of the site is described in Robson and Romero (1981), Robson (1996), and in the preliminary assessment for the site (CDPHE 1992). Information derived from these sources is summarized below.

There are two primary groundwater systems underling the site: an upper shallow alluvial system and a deeper bedrock aquifer (the Denver Aquifer). The two systems are separated by more than 70 feet of low permeability claystone. The depth to groundwater in the shallow alluvial system ranges usually ranges from about 10-20 feet below the ground surface. The shallow alluvial system is comprised of sand and gravel that contains various amounts of clay and silt. In some areas these coarse grained materials grade to a fine material, with clay and silty materials predominating. Due to the higher hydraulic conductivity of the weathered bedrock than the underlying unweathered bedrock, shallow groundwater preferentially flows horizontally in the alluvial/weathered unit rather than downward towards the deep bedrock aquifer (CDPHE 1992).

Regionally, the direction of groundwater flow in the upper alluvial system is to the east-southeast toward the South Platte River (see Figure 2-2). Flow rates range from 20 to 200 feet/year. Once the flow enters the South Platte River alluvium, the direction then turns to the northeast (parallel to the river) (CDPHE 1992).

2.6 REGIONAL METEOROLOGY

The mean annual precipitation in Denver, Colorado is 15.4 inches. The months with the highest and lowest average precipitation are May and January, with 2.4 and 0.5 inches, respectively. The average ambient temperature in Denver ranges from 29.7 °F in January to 73.5 °F in July (Western Regional Climate Center 2004).

3.0 SITE INVESTIGATION

3.1 REVIEW OF EXISTING DATA

The site investigation was begun by searching existing reports and publications to determine if there were any reliable data that could be used to describe conditions at the VBI70 OU3 site, and to identify significant data gaps that would require additional data collection at the site. A summary of the previous studies at or in the vicinity of the VBI70 OU3 site is provided in USEPA (2003a). As discussed in USEPA (2003a), of the six potentially relevant studies located, only one investigation included data from sampling locations within the boundaries of the VBI70 OU3 site. This investigation was the RI for the ASARCO Globe Plant (TRC 1988), which is located approximately one mile northeast of the VBI70 OU3 site. During this study, a total of 6 soil samples were collected from three locations within the boundaries of the VBI70 OU3 site. The samples were collected at each location from two depths: (0-5 cm and 5-15 cm below the surface), and were analyzed the 23 Target Analyte List (TAL) metals. The study found that 2 of the 6 soil samples collected at VBI70 OU3 exceeded background concentrations for cadmium, lead and zinc (Table 3-1). Although the ASARCO Globe Plant RI did not include any groundwater samples from within the boundaries of the VBI70 OU3 site, groundwater samples were collected from 5 locations (private wells and/or monitoring wells) that are likely downgradient (east/northeast) of the VBI70 OU3 site. Private wells were sampled bi-monthly during a 1 year period and samples were analyzed for total arsenic, cadmium, lead and zinc. Monitoring wells were sampled either on a monthly or quarterly basis over a period of two years and were analyzed for dissolved TAL metals, common ions, organics, pH, temperature and conductivity. Additional groundwater samples were collected from two of these wells (GW-46 and GW-15) on a quarterly basis during the period of 1993-2001. Samples were analyzed for dissolved arsenic, cadmium, lead and zinc. The analytical results are presented in Appendix C.

The RI for the Globe Plant identified two anomalous shallow groundwater plumes with elevated levels of cadmium and zinc were identified upgradient (west and south) of the Globe Facility (north and northeast of OU3). The source of the plume to the west of the Globe Plant was thought to be a fertilizer and chemical plant formerly located between 53rd and 54th Avenue. The source of the plume located south of the Globe Plant was unknown. The authors noted that the

plume is downgradient of the former Argo Smelter, suggesting that OU3 might be a possible source (TRC 1988).

3.2 SITE SAMPLING AND RESULTS

3.2.1 Purpose and Overview of Sampling

As discussed above, only very limited soil data and no groundwater data were located for the VBI70 OU3 site. Because of this data gap, a Remedial Investigation was planned and conducted at the site in order to collect sufficient data to adequately characterize the nature of any site-related impacts to soil and groundwater and to determine if smelter-related contamination exists at a level requiring remedial action to protect human health and the environment.

Details on the sampling plan are provided in USEPA (2003a). In brief, a phased sampling strategy was selected to collect data on contaminant levels in soil and groundwater at the site. The initial phase (referred to as Phase I) involved the collection of preliminary data to determine if contaminants are above a level of potential concern in soil and/or groundwater. For soil, the Phase I investigation involved the collection of both on-site surface and subsurface soil samples. For groundwater, the Phase I investigation sought to collect groundwater samples from upgradient and downgradient locations at the Site to determine site-related impacts to groundwater. Based on the results of the Phase I investigation, additional data would be collected (if needed) to help refine estimates of the nature and extent of contamination and to support human health and ecological risk assessment and risk management decisions.

3.2.2 Soil Sampling and Results

Soil borings were collected from 36 locations on the site. Figure 3-1 presents the Phase I soil sample locations. Surveyed coordinates for each location are provided in Appendix A. The majority of the locations sampled were from areas of the site that are most likely to have been impacted by historic operations or releases (e.g., from within the former smelter facility and buildings where potentially hazardous waste generating smelting/refining processes occurred). These locations were selected based on a review of the available information on the smelter operations (Fossett 1973), historical building locations (Figure 3-2 and Figure 3-3) and available

aerial photographs (NARS 1937). Additionally, samples were collected at 10 locations outside the area of the historical smelter facilities to collect data at locations where disposal of wastes may have occurred and also at locations near the eastern and western areas of the site boundary to facilitate the collection of upgradient/downgradient groundwater samples (see Section 3.2.3).

Soil borings were completed from the surface (below the pavement) until groundwater or refusal (whichever came first) using a direct push drill rig. Details on the direct-push drilling and sampling system are provided in the Field Sampling Report (USEPA 2004a) and in the Standard Operating Procedures of the QAPP/SAP (USEPA 2003a). In brief, a dual tube system (consisting of a 1 inch inner plastic liner and 2 inch outer cutting shoe) was advanced at a sample location until refusal. Once retrieved, the continuous cores were logged by a geologist, screened with an organic vapor analyzer (OVA) (as necessary, based on visual inspection) and sampled. Appendix B presents the soil boring logs for each borehole.

Soil samples were collected from each distinct soil horizon (identified by visible examination of the continuous core) starting below the most recent man-made cap (i.e., asphalt, fill material etc.). Thus, the first sample in each boring represents the surface immediately below the cap, and samples of deeper horizons were taken based on visual identifications. The most recent man-made cap typically consisted of asphalt overlying recent structural fill composted of loose gravel, sand or topsoil (Appendix B). If a thin, distinct, man-made cap could not be readily identified, the first soil sample was collected starting at the surface. The 8-ounce soil sample jars were filled by hand (using disposable gloves) by collecting soil over the estimated soil horizon intervals.

The borings at Station 12 and Station 13 were completed as hand auger borings due to difficulty accessing these stations with the drill rig. Soil samples from these stations were collected in a clean auger bucket, were removed from the auger by hand (using disposable gloves) and placed in a plastic bag for homogenizing, prior to filling the sample jar.

After collection, pre-printed sample labels were affixed to each sample jar and also to the field data sheet. Samples were placed in coolers with ice and transported to Severn Trent Laboratories (STL) in Arvada, Colorado. Samples were analyzed for the 23 TAL metals by method SW-846 6010B ICP AES and SW-846 7471A cold vapor (mercury). Appendix C

presents the analytical results for soil samples. Summary statistics for concentrations of metals in site soils are presented in Table 3-2.

In addition to the collection of soil samples at the site for analysis of metals, four additional samples of the bedrock claystone were collected during the Phase I investigation for possible geotechnical analyses (i.e., sieving and particle size distribution) to provide estimates of bedrock permeability (if necessary) for the RI and Feasibility Study (FS). These samples were collected at the following stations: 10, 12, 14 and 19 and are currently being held in custody by Knight Piésold.

3.2.3 Groundwater Sampling and Results

Groundwater samples were collected during four different sampling rounds. The details of each sampling round are described below.

Round 1

The first round of groundwater sampling was conducted in December 2003, in conjunction with the Phase I soil borings. Based on the expectation that most borings would encounter groundwater, it was originally planned that water would be collected from four upgradient (westerly) and four downgradient (easterly) areas of the site (USEPA 2003a). However, groundwater was encountered in only 2 of the 36 soil borings (Stations 04 and 07; see Figure 3-1). Therefore, the QAPP/SAP was modified (as verbally agreed upon by Knight Piésold and EPA) to collect groundwater samples at any location where groundwater was encountered during field sampling activities. As a result, a total of 2 groundwater samples were collected (one from Station 04 and one from Station 07).

Groundwater samples were collected by removing the dual tube drill assembly, placing a disposable tip on the outer drill tube and placing a 1 inch diameter polyvinyl chloride (PVC) slotted well screen in the inner part of the assembly to create a temporary 1-inch-diameter well string inside the boring. Groundwater samples were collected using a peristaltic sampling pump with new 3/8 inch polyethylene tubing at each sampling location. Groundwater collected for dissolved metals analysis was filtered using a 0.45-micron in-line filter prior to filling a one-liter

pre-acidified sample container. Samples collected for total metals analysis were placed in pre-acidified containers without filtering. Field parameters (pH, conductivity, temperature) and water level measurements were also collected.

After collection, pre-printed sample labels were affixed to each sample jar and also to the field data sheet. Samples were placed in coolers with ice and transported to the USEPA Region 8 Laboratory in Golden, Colorado. Samples were analyzed for both total and dissolved TAL metals by EPA Method 200.7 ICP or 200.8 ICP/MS and EPA Method 200.9 cold vapor atomic absorption (CVAA) (mercury). The analytical results for groundwater samples are presented in Appendix C.

Round 2

As described above, groundwater samples were collected from only two stations at the site during the first round of sampling. These data were not adequate to determine site-related impacts to groundwater, nor were they adequate to determine the direction of local groundwater flow at/from the site. Thus, five additional permanent monitoring wells were installed in April 2004 to collect additional data to further characterize the local direction of groundwater flow and the nature of metals in groundwater that may be migrating off-site. Wells were monitored on a monthly basis throughout the spring (typically a period of high precipitation). The location of the Round 2 monitoring wells are presented in Figure 3-4, and the surveyed coordinates of each well are provided in Appendix A.

Details on the installation and documentation of the Round 2 monitoring wells is provided in USEPA (2004b). In brief, monitoring wells were installed by ESN Rocky Mountain, Golden, Colorado with oversight by Knight Piésold using a direct-push drill rig (AMS Power Probe 9600) on April 8, 2004. Direct-push soil borings were advanced to depths ranging from 10-20 feet. Wells were installed in unconsolidated aquifer materials (fill, alluvium) overlying a claystone bedrock aquitard layer. Wells were constructed by lowering 5- or 10-foot lengths of 2-inch diameter PVC screen and blank casing into the outer drilling casing. The well screens (factory-slotted, 0.010-inch, Schedule 40 PVC) were set into the claystone bedrock or into bentonite poured into the bottom of the boring to adjust the height of the bottom of the well

screens. The boring logs and well construction diagrams for Round 2 monitoring wells are provided in Appendix B.

Wells were sampled on a monthly basis (as groundwater was available) during the May to July 2004 period. Table 3-3 summarizes the results of each sampling attempt (groundwater sample collected or dry) during the first four months of sampling. Because water levels and volumes varied from well to well, groundwater samples were collected by one of the following two procedures: (1) groundwater samples were collected after purging 3 casing volumes from the well (for wells with good recoveries); or (2) groundwater samples were collected from water pumped from the well without prior purging (for wells with little immediate recovery of sufficient water for sampling after being pumped dry). All wells were sampled without prior purging, except for MW-33. Filtered and unfiltered groundwater samples were collected for dissolved and total metal analysis, respectively, as described above. If low groundwater yields were observed at a well (i.e., less than 250 ml), preference was given to collecting a sample for dissolved analysis only. Following collection, samples were placed in iced coolers and delivered to Severn Trent Laboratory in Denver, Colorado for dissolved and total TAL Metals analysis by method SW-846 6010B, 6020B and 7470A (mercury). The analytical results are presented in Appendix C. Summary statistics for the concentration of total and dissolved metals in site groundwater are presented in Table 3-4. Depth to water measurements were collected over a period of 3 months and are presented in Table 3-5 for each monitoring well.

Round 3

Round 3 focused on collecting groundwater from 10 off-site locations that are likely downgradient (east and northeast) and upgradient (southeast) of the VBI70 OU3 site (see Figure 3-4 and Figure 3-5) to determine if contamination observed in on-site wells could be impacting groundwater downgradient of the site. This included collecting one round of groundwater samples from four of the ASARCO Globe Plant monitoring wells located east/northeast of the site (downgradient) in November 2004 and from 6 of 7 proposed geoprobe locations to the east (downgradient) and southeast (upgradient) of the VBI70 OU3 site in May 2005 (see Figure 3-5). As mentioned in Section 2, the direction of regional groundwater flow in the region of the site is believed to be generally to the east (towards the South Platte River), with the direction turning northeast (parallel to the South Platte River) as groundwater moves from the western terrace to

the South Platte alluvium. Based on this, geoprobe locations PS-5 through PS-7 were placed in locations judged to be upgradient of the Globe Plant monitoring wells and downgradient of the VBI70 OU3 site in the western most margin of the South Platte Alluvium. Geoprobe locations PS-1 through PS-4 were also placed in the western margin of the South Platte Alluvium but in an area thought to be upgradient of groundwater that could be migrating east from the VBI70 OU3 site. Boring logs for the 7 geoprobe sample locations are provided in Appendix B. During Round 3, a total of 10 samples were collected and analyzed for total and dissolved TAL metals by Severn Trent Laboratory using methods SW-846 6010B, 6020B and 7470A (mercury). The analytical results are presented in Appendix C. Summary statistics for dissolved and total chemicals measured in all off-site groundwater samples (Round 3 Results, Globe RI and Globe Quarterly Monitoring) are summarized in Table 3-6.

Round 4

Round 4 focused on defining the eastern lateral limit of the groundwater contamination in the Platte Valley alluvium located downgradient (east/northeast) of the VBI70 OU3 site and to determine if the groundwater plume is isolated from the South Platte River (Knight Piésold 2005a). Groundwater samples were collected from nine, direct-push (geoprobe) boring locations using the sampling proceedures specified in the QAPP/SAP (USEPA 2003a). These geoprobe locations (designated PS-11 through PS-19) are shown in Figure 3-4. Groundwater samples were analyzed for concentrations of the TAL metals in the dissolved and total fractions, by Severn Trent Laboratory using methods SW-846 6010B, 6020B and 7470A (mercury). The analytical results are presented in Appendix C. Summary statistics for dissolved and total chemicals measured in all off-site groundwater samples (Round 3 Results, Globe RI and Globe Quarterly Monitoring) are summarized in Table 3-6.

3.2.4 Surface Water Sampling and Results

As mentioned in Section 2, there are no permanent surface water bodies located at the VBI70 OU3 site. However, the outfalls from two storm sewer drains are located at the northwest portion of the VBI70 OU3 site (see Figure 3-5). These drains collect water from the VBI70 OU3 site and surrounding areas. Water from the drains flows into a drainage ditch that runs east/west, parallel to 48th Avenue. During March 2005, a sample was collected from each drain outfall and

analyzed for total metals by Severn Trent Laboratory using methods SW-846 6010B, 6020B and 7470A (mercury). The results are presented in Appendix C and are summarized in Table 3-7.

3.3 DATA USABILITY

To help ensure that data collected during the site investigation were of adequate quality to use in site characterization and decision-making, soil and groundwater data collected during the Phase I investigation were validated externally and assessed internally through the analysis of quality control (QC) samples. Each of these processes and the associated conclusions regarding data usability are described below.

3.3.1 Data Validation

Analytical data generated during the Phase I investigation were reviewed and validated in accordance with USEPA National Functional Guidelines for Inorganic Data Review (USEPA 1994), analytical method requirements (SW-846), and project plan requirements (USEPA 2003a). As specified by the project plan (USEPA 2003a), full validation was performed on 10% of the field samples collected and an abbreviated (cursory) validation was conducted on all remaining samples. The elements that were reviewed during each type of validation are described in USEPA (2003a). The detailed data validation reports are presented in Appendix D. Most results were within the prescribed data quality criteria and no changes were made to the analytical results or data qualifiers. However, when data quality criteria were not met, qualifiers were assigned to sample results in accordance with project plans, test methods, and national guidance. Table 3-8 presents the qualifiers assigned to sample results during data validation. Details on the basis of assigning validation qualifiers are summarized in the data validation reports (Appendix D).

Table 3-9 summarizes the data usability rules used for this project. Based on these rules, all Phase I data were deemed suitable for use in site characterization and risk assessment with the exception of two results (in an equipment decontamination rinsate sample) that were rejected (assigned an "R" qualifier).

3.3.2 Data Quality Assessment

The quality of the environmental data collected during the Phase I field investigation was assessed by evaluating the Precision, Accuracy, Representativeness, Comparability, and Completeness (PARCC) of the data, as described below.

Precision

Precision is the agreement between a set of multiple measurements without knowledge of the true value. Agreement is expressed as the reproducibility of duplicate measurements. During the Phase I Investigation, precision was measured by the analysis of field split samples and laboratory duplicate samples. Details on the objectives and results of these quality control (QC) samples are presented in Appendix E and summarized in Table E-1 (see Appendix E). As shown in E-1, field split and laboratory duplicate samples were collected at the required frequency specified by project plans. As shown in Table E-2, the quality assurance criteria were met for all soil field split samples. Field split samples were not evaluated for Round 1 or Round 2 water samples (groundwater or rinsate) due to the frequency of samples collected or the volume of groundwater recovered. Field split samples were collected during Round 3 and 4 water sampling at the required frequency. Laboratory duplicate samples were prepared for Round 1 groundwater samples only. If a laboratory duplicate was not available for a sample group, in accord with analytical Method SW-846 6010, Matrix Spike Duplicate (MSD) and matrix spike (MS) results were used as a proxy to evaluate laboratory precision. As seen in Table E-7, Part A, most analyses (158 out of 164 = 96%) in soil are within QC acceptance criteria, with the exception of a few analytes (mercury, lead, aluminum, and iron) in four different duplicate samples. Results for water samples (groundwater and rinsates) are shown in Table E-7, Part B. As above, most results are within the QC acceptance criteria, with the exception of cadmium and lead in one Round 1 groundwater sample. Results for chemicals in field samples analyzed in the same sample batch as the laboratory duplicate(s) that exceeded the duplicate QC criteria were "J" qualified to indicate that the reported concentration is estimated because QC criteria were not met (see Appendix D). Because the frequency of samples exceeding QC acceptance criteria for precision is low, and because there is no consistent pattern of exceedences across analytes or media, the overall precision of the analysis of metals in soil and water is judged to be adequate for the remedial investigation.

Accuracy

Accuracy is a measure of how close a sample result is to the "true" value. Analytical accuracy was assessed in the Phase I investigation by inserting a series of samples of known concentration, including both laboratory control samples (LCS) and performance evaluation (PE) samples, and comparing the result to the known value. In addition, recovery of spiking materials in MS/MSD samples was evaluated. A detailed evaluation of these samples is presented in Appendix E (Tables E-4 through E-6) and the results are summarized in Table E-1. As seen, LCS, PE ,and MS samples were analyzed at the required frequency specified by project plans. Most of these QC sample results were within specified acceptance criteria, indicating that the data are within acceptable accuracy bounds. Occasional exceedences were observed in a few QC samples, but overall there was no clear pattern suggesting systematic error. Field samples analyzed with the LCS or MS samples that exceeded QC criteria were "J" qualified to indicate that the reported concentration of the analyte is estimated due to uncertainty of the accuracy based on the QC sample results.

Accuracy was further evaluated through the preparation and analysis of blanks. Both equipment decontamination (rinsate) field blanks and analytical method blanks (MB) were analyzed to determine if any field or laboratory contamination was being introduced to the samples. A detailed evaluation of these samples is presented in Appendix E (Table E-3 and E-8) and the results are summarized in Table 3-8. As seen, rinsate and MB samples were analyzed at the required frequency specified in project plans. All MB results were within QC acceptance criteria, indicating that no contamination was introduced into soil or groundwater samples by the laboratory. As seen in Table E-3, most rinsate samples prepared from decontaminated groundwater sampling equipment are within QC acceptance criteria and do not contain detectable concentrations of metals, with the exception of one groundwater rinsate sample with a detectable concentration of calcium. For rinsate samples prepared from decontaminated soil sampling equipment, all samples exceed QC acceptance criteria (detectable concentration of a metal) for at least one analyte in each sample. The chemicals frequently detected in rinsates from soil sampling equipment include aluminum, calcium, iron and, in one case, manganese. This suggests that some cross-contamination between soil samples may have occurred during field collection activities. However, because the detected concentrations in rinsates were low

(typically within 1-2 times the detection limit), and because all of these analytes occur at relatively high levels in soil, the amount of cross-contamination is not likely to significantly alter the measured values in the soil samples. In addition, none of these chemicals are suspected to be a cause for significant human health concern (see Section 6). Thus, these rinsate results do not suggest the soil sample results are unreliable.

Representativeness

Because contaminant concentrations may vary in space and time, it is important to review whether the data set for a site is representative of site conditions. At VBI70 OU3, soil samples were collected from locations that were spatially distributed across the entire VBI70 OU3 site, with the majority from locations that were intended to be from likely areas of contamination within the footprints of the former smelter buildings. Thus, the data set of concentrations of metals in soils measured at the site may be biased high. As mentioned previously, groundwater was encountered at only a few location, so it is difficult to assess if groundwater data are representative of conditions at the site.

Comparability

Comparability is a data quality concern in cases when data have been collected in two or more independent sampling and analysis efforts because of the different types of samples that could be collected (grab vs. composite, filtered vs. unfiltered, etc.), and the analytical methods (and associated detection limits) that could be used for sample analysis. For soil both soil and groundwater, data were available from the Phase I investigation of the VBI70 OU3 Site and studies at the nearby Globe Plant. The type of samples collected in these studies were similar in nature (grab soil and water samples, unfiltered and filtered water samples) and analyses (metals). The sample attributes are documented in each respective project plan. Based on this, no elements of the combined datasets are judged to be incompatible. Thus, the data are likely comparable and can be combined and for use in the remedial investigation and risk assessment for the VBI70 OU3 site.

Completeness

Data are considered complete when a prescribed percentage of the total number of intended measurements and samples are obtained. Soil samples were collected from 36 of the 37 (97%) proposed borings at the site. Thus, the completeness of the soil data set collected during Phase I is adequate in describing site conditions.

For groundwater, sampling did not detect water in most boring locations, indicating that a continuous shallow aquifer does not exist beneath the former smelter site. Thus, the original objective of collecting an adequate number of groundwater samples from upgradient and downgradient locations to determine site-related impacts (if any) and groundwater flow becomes moot. Because the soil borings suggested there was a discontinuous shallow groundwater aquifer below the eastern portion of the VBI70 OU3 site, the sampling plan was modified to install new wells in the eastern part of the site and to collect periodic water samples from these wells (if water was present). As a result, a total of 15 grab samples were collected during a 3 month period from 5 monitoring wells located in the discontinuous aquifer. During Rounds 3 and 4, a total of 26 grab samples were collected from 19 off-site locations to determine if contamination at the VBI70 OU3 site is impacting groundwater downgradient of the site. Based on this, the number of samples satisfies the goals of the revised sampling plan and the groundwater data are judged to be of adequate completeness.

Data Quality Assessment Conclusions

Based on the data quality evaluation described above and presented in Appendix E, it is concluded that the data are of adequate quality for use in the in describing current conditions at the site and for use in human health and ecological risk assessment.

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 SOIL

4.1.1 Nature of Soils at the VBI70 OU3 Site

Soils underlying the VBI70 OU3 site can generally be characterized as fill (consisting of gravelly sand and clay) or sandy clay and clayey sand overlying weathered claystone. Depth to claystone at most locations across the site is typically 10 feet or less (see Appendix B). As seen in the boring logs in Appendix B, materials potentially associated with the former smelter (including brick fragments, cinder or slag) were identified in the fill material at several borings at the site. Most of these borings are located within the footprints of the historical smelter buildings (soil borings 3 through 8, 12, 15, 17 through 19, 22, 26, 27 and 32), although bricks were identified in some borings collected at locations located on the perimeter of the former smelter and/or outside of the former smelter (soil borings 9, 16, 20, 30, 31, 34).

4.1.2 Nature and Extent of Contaminants in Soil at the Site

Concentrations of metals in soil collected during the Phase I investigation were evaluated to determine if site soil had been impacted by former smelter operations at the site. This was done by comparing site data to background concentrations of metals collected from regional soils. The details of these analyses are presented in Appendix F and are summarized below.

Background concentrations of metals in soils were estimated from data collected by the U.S. Geological Service (USGS) (Shacklette and Boerngen 1984) from 7 counties (Arapahoe, Clear Creek, Douglas, Elbert, Jefferson, Park and Weld) in Colorado surrounding the Denver Metro Area (see Figure 4-1). The 99th percentile of the distribution of background concentrations was calculated for each chemical from the raw background data set, assuming a lognormal distribution of the data. This value represents the high end concentration of a metal in soil that is likely to naturally occur in the region. For chemicals where background data were not available for a chemical (cadmium and silver), or the number of background samples were not adequate to estimate the 99th percentile concentration (antimony and thallium), the high end of the typical

range of concentrations found in native soils reported by Dragun (1988) was used as an estimate of the upper end of background. The raw data and summary statistics are presented in Appendix F (Tables F-1 and F-2, respectively). Table 4-1 summarizes the soil concentrations selected to characterize the high end of the background distribution.

The Phase I soil data were compared on a sample-by-sample basis to the values summarized in Table 4-1. Appendix F (Table F-3) presents the detailed results, and Table 4-2 summarizes the frequency of exceedences for each chemical. In this approach, a data set in which samples exceed the 99th percentile background concentration at a frequency of 1% or less would be considered to come from the same distribution as background (i.e., is not different from background), while a data set that contains more than 1% of the samples above the 99th percentile of background would be considered to be higher than background. As seen in Table 4-2, based on this approach, the concentrations measured in site soils for some chemicals are not different than background, but several chemicals appear to occur at concentrations higher than expected in background. These chemicals include arsenic, cadmium, copper, lead and zinc and, to a lesser extent iron, manganese, mercury, nickel, selenium and silver.

Figures 4-2 through 4-12 present the spatial distribution of samples that exceed background for each chemical. As seen, most of the samples that exceed background concentrations are located within the historical footprint of the former smelter facilities. This area of the site is defined by SB-32 to the north and east, SB-25 to the south and SB-10 to the west, with the exception of one sample collected at SB-36. At this station, which is located on the eastern-most border of the site, one sample exceeds background for cadmium. Additionally, one sample collected within the former smelter buildings at boring 7 at a depth of 10-12 feet bgs contained high levels of arsenic and lead (2,900 and 1,600 mg/kg, respectively). As seen in Table 4-3, arsenic and lead concentrations in samples collected above and below this depth and at surrounding stations do not appear to be elevated at the same level. Thus, the arsenic and lead concentrations at SB-07 appear to be a localized area of contamination, isolated to the depth range of 10-12 feet bgs.

4.2 SHALLOW GROUNDWATER

4.2.1 Shallow Groundwater Beneath the Site

Nature of Shallow Groundwater at the VBI70 OU3 Site

Soil borings and well installation logs were used to help refine knowledge on the attributes of shallow groundwater at the site. Based on these data, it appears that there are two types of groundwater present at the VBI70 OU3 Site: 1) perched pockets of groundwater at several locations beneath the footprints of the former smelter buildings; and 2) a discontinuous shallow groundwater aquifer located to the east of the former smelter buildings. Figure 4-13 presents a conceptual model of groundwater at the VBI70 OU3 Site.

Perched Groundwater Beneath the Smelter Site

Groundwater samples collected during Round 1 were determined to be from localized pockets perched within old and new fill materials located beneath former smelter buildings in the central portion of the VBI70 OU3 Site (USEPA 2004a). Based on the boring logs, fill materials are the only likely aquifer materials that were identified in the vicinity of the former smelter buildings. No alluvium (defined as gravelly sand, silty sand, but not clayey sand) was identified in 31 of the 36 soil borings at the Site, from soil boring 32 (SB-32) and monitoring well 32 (MW-32) to the west of the site (see Figure 3-4). A minor exception is at SB-10, at the far west end of the site, where silty sand was identified from about 0.5 to 2 feet bgs. Soil borings to the west (SB-28, SB-29, SB-30, and SB-31) and south (SB-23, SB-24, SB-25, SB-26, and SB-27) of the former smelter site did not have any indications of alluvium or perched groundwater (USEPA, 2004b). The boring at MW-32 consists of newer, clean fill overlying claystone bedrock. Natural alluvium was not identified. In retrospect, a 1 to 2 foot layer of silty sandy clay identified at SB-32 (see Appendix B) can be interpreted to be newer fill and not alluvium (USEPA 2004b).

Based on the boring log information described above, it is likely that the perched groundwater system is located on a natural stream terrace associated with the South Platte River System. If this is the case, excavations associated with construction (the smelter, the interstate highways,

the industrial park) may have removed natural alluvium that likely existed on the terrace. Therefore, fill materials are the only potential aquifer materials that remain in this area of the site (USEPA 2004b).

The areal extent of the perched aquifer system is estimated as the approximate area of the former smelter site north of Interstate 70, extending east to the estimated location of the local terrace/escarpment near MW-32 (see Figure 3-4). The total estimated area where perched groundwater might be present is roughly bounded on the west by SB-10, on the south by SB-21, on the north by SB-01, and on the east by MW-32. This area forms a rectangle approximately 1,400 feet (east/west) by 750 feet (north/south). The elevation of the perched groundwater in this system is approximately ranges from 5,210 ft amsl (at SB-04) in December 2004 to 5,202 - 5,204 (at MW-32 in June and July 2004), or approximately 4 to 11 feet bgs (USEPA 2004b).

As mentioned above, monitoring well 32 is considered to be located at the eastern edge of the perched groundwater at the site. The well was installed about 75 feet to the east (downslope) of SB-32, where the discontinuous shallow groundwater located east of the former smelter buildings (described in next section) would likely slope downward from beneath the Village Inn parking lot toward alluvium identified beneath the grounds of the Best Western Hotel. During installation of MW-32, the claystone bedrock surface was found to exhibit little slope between SB-32 and MW-32 (claystone in both borings at approximately 5,203 feet amsl). The claystone bedrock appears to have the form of a flat terrace, or possibly an excavated escarpment. East of MW-32, there is apparently an abrupt 21-foot drop in elevation of the claystone bedrock to SB-33/MW-33 (claystone in both boreholes at approximately 5,182 feet amsl), likely a second natural stream terrace associated with the South Platte River System (USEPA 2004b).

Discontinuous Shallow Groundwater in the Eastern Part of the Smelter Site

Discontinuous shallow groundwater was identified at the VBI70 OU3 Site to the east of the former smelter buildings. This shallow unconfined aquifer was defined by the presence of alluvium (as defined above), which was consistently observed in all soil borings east of the terrace or escarpment near SB-32 and MW-32 (see Appendix B and Figure 3-4). It is likely that this alluvium was deposited upon a natural stream terrace associated with the South Platte River system. If so, this second terrace with alluvium is about 20 feet lower in elevation than the

terrace/escarpment to the west of MW-32 underlying the former smelter buildings (USEPA 2004b).

Table 4-4 presents the water levels and the estimated saturated thickness of alluvium at four of the Round 2 monitoring wells installed through alluvium. As seen, the depth to groundwater in the discontinuous shallow unconfined aquifer ranges from 8 to 20 feet bgs, with depths decreasing with increasing distances to the southeast, and the saturated thickness of the alluvium above the claystone appears to be less than 1 foot (0.2 ft to 0.9 feet). In MW-35 and MW-36 on the eastern boundary of the site, water appears to trickle down into the sump formed where the bottom of the well screen sites within the top of the claystone bedrock. Thus, at these stations, water levels did not rise above the top of the bedrock to produce a measurable saturated thickness in the alluvium. This is consistent with the very low volumes of recharge to the wells, measured on the order of less than a liter per day (as described in Section 3.1.3). In the area of MW-33 and MW-34, there is evidence that a small saturated zone develops temporarily, for at least part of the year, as indicated by the absence of groundwater in this area during the Round 1 sampling (December 2003) and the presence of groundwater during Round 2 sampling (May - July 2004) (USEPA 2004b). Screening level flux estimates for the saturated zone at MW-33 and MW-34 range from 1.1 to 24 cubic feet per day (USEPA 2004b and 2004c).

Nature and Extent of Contaminants in Groundwater at the VBI70 OU3 Site

Concentrations of metals in groundwater collected during the Phase I investigation were evaluated to determine if groundwater has been impacted by former smelter operations at the site. Ideally, this question would be answered by comparing groundwater collected down-gradient of the site and comparing those values to up-gradient concentrations. However, as discussed previously, groundwater was not encountered in any up-gradient locations during the Phase I Investigation, so data are not available for a background-based evaluation of site-related impacts to groundwater. However, it is possible to examine the spatial and temporal patterns of contaminant levels in on-site groundwater samples and compare concentrations to federal drinking water standards in order to draw tentative inferences about the impact of the site on local groundwater.

Spatial Patterns

Appendix G presents the concentrations of chemicals measured in the dissolved and total fractions of groundwater by sampling station collected during each sampling event of the Phase I remedial investigation. The upper panels of Table 4-5 and Table 4-6 summarize the results.

For dissolved metals (Table 4-5), several chemicals occur at higher levels in samples of perched groundwater collected from within the historical footprints of former smelter buildings (soil boring 07 and/or 04) than from samples of the discontinuous groundwater collected at locations east of the former smelter buildings (MW-33, MW-34, MW-35, MW-36). This includes aluminum, arsenic, cadmium, cobalt, iron, manganese, thallium, vanadium and zinc (Figure 4-14). This pattern suggests that releases of site-related chemicals have occurred in the area of the perched groundwater. However, only some of these chemicals exceed MCL values in one or both of the on-site perched groundwater locations (SB-04 and SB-07), including arsenic, cadmium, iron, manganese, thallium, and zinc. Concentrations drop below MCLs for most of these chemicals in the discontinuous groundwater east of the former smelter area, although multiple exceedences of MCLs still exist for cadmium and manganese. These results are consistent with the possibility that there may be some release of contaminated groundwater from the perched groundwater into the discontinuous groundwater east of the former smelter.

Generally similar results are observed for total metals (Table 4-6 and Figure 4-15), although several additional chemicals exist at concentrations above MCLs in perched groundwater beneath the former smelter (aluminum, antimony, beryllium, chromium, copper, lead, mercury, silver, thallium) and in the discontinuous groundwater east of the former smelter (aluminum and iron). Interpretation of the spatial pattern for total metals is more uncertain, since suspended material in groundwater usually does not undergo substantial migration.

Temporal Patterns

Because only one sample was collected from each of the two on-site stations that intersect perched groundwater, it is not possible to draw conclusions about temporal variability at these locations. For sampling stations in the discontinuous aquifer east of the former smelter, the

variability between samples as a function of time is generally small, although it is important to note that the data set includes only 1-4 samples per well and spans only a four-month time interval. Thus, the full magnitude of temporal variability may not be captured in this data set.

4.2.2 Off-Site Groundwater

As noted above, the general direction of shallow groundwater flow in the region of the site is easterly, changing to northeast after entering the South Platte River Valley alluvium. For the purposes of this report, "off-site" groundwater refers to areas east of the site and in the South Platte alluvium east/northeast of the site that may have been impacted by transport of site-related contaminants in shallow groundwater, either in the past or under current conditions.

Off-Site Hydrogeology

As described above and shown in Figure 4-16, most of the off-site wells that provide information on impacts to off-site shallow groundwater are located east/northeast of the VBI70 OU3 site, in the Platte River Valley alluvium. Monitoring well GW-17 is the exception and appears to be located on the bedrock terrace. Similar to the discontinuous shallow groundwater observed at the eastern portion of the VBI70 OU3 site, this shallow unconfined aquifer is composed of alluvium (gravelly sand and/or silty sand). Depth to water is approximately 11-14 feet below ground surface. As seen in Appendix B and Figure 4-16, the approximate saturated thickness ranges from a few feet (at the margin of the Platte River Valley alluvium, see PS-7) up to 20 feet, increasing in thickness with increasing distances to the east and north. Screening level flux estimates for the saturated zone at the margin of the Platte Valley alluvium range from 4.6 to 46 ft^3/day (see Figure 4-17).

Nature and Extent of Contaminants in Off-Site Groundwater

Spatial Pattern of Dissolved Metals in Off-Site Groundwater

Potential impacts to off-site groundwater downgradient of the site were evaluated by comparing concentrations of metals in wells located upgradient of the site in the Platte River Valley alluvium (wells PS-1, PS-3 and PS-4) to concentrations observed in downgradient wells. These

data are presented in Table 4-5 (dissolved metals) and figures showing the spatial distribution of these data are provided in the upper panels in Appendix H.

Inspection of the upper graphs in Appendix H reveal that several chemicals occur at higher levels in groundwater samples collected downgradient of the site than from groundwater samples collected upgradient of the site. The most convincing elevations are observed for arsenic, cadmium, lead, potassium, and zinc. Marginal elevations that may or may not represent authentic effects are noted for aluminum, cobalt, iron and possibly manganese. For arsenic (Figure H-3) and lead (Figure H-12), the data which suggest a spatial pattern of elevated downgradient concentrations were collected as part of the 1988 Globe RI. More recent data, collected in 2004-2005, do not exhibit this same spatial pattern. The reason for this difference in spatial pattern between the older and the newer data is unknown, but suggests that if there was an elevation in the past, the effect is no longer observable.

For zinc (see Figure H-23), concentration values tend to decrease as a function of distance away from the site, both to the north and the east. This pattern is consistent with the hypothesis that the site may have been the source of the release. For cadmium (Figure H-6), the concentration pattern is not so clear. Concentrations of cadmium do tend to decrease with increasing distance to the east (see Stations PS-7, PS-6 and PS-5), but appear to increase with increasing distances northeast (GW-46, GW-16, GW-15). However, this unexpected spatial pattern is largely driven by the high concentrations measured at GW-15. High concentrations of other metals, including arsenic and lead, were also measured in both current and historical groundwater samples collected at this location, suggesting that there could be other influences in addition to site-related impacts influencing the concentrations of metals in groundwater at this well.
Table 4-5 indicates by shaded cells concentration values that exceed drinking water MCL values. As seen, some exceedences occur for arsenic, cadmium, iron, lead and manganese, with cadmium being the most common.

Spatial Pattern of Total Metals in Off-Site Groundwater

Spatial patterns of total metals are shown in the lower panels of Appendix H. Inspection of these graphs reveals a pattern of elevated concentrations in downgradient wells compared to upgradient wells for cadmium and potassium, with possible elevations for arsenic and zinc.

These data support the findings based on the dissolved metal measurements, although measurements of total metals are generally more difficult to interpret because of the potential for contamination of samples by disturbed sediments when sample collection occurs. Several chemicals in the total fraction exist at concentrations above drinking water MCLs, including aluminum, arsenic, barium, beryllium, cadmium, chromium, iron, lead, manganese, and thallium. Of these chemicals, arsenic, cadmium, and lead most frequently exceeded the MCL.

Temporal Variation

Most wells have an insuffient number of samples to perform a meaningful time trend analysis. However, two off-site wells (GW-15 and GW-46) were monitored on a quarterly basis during 1993 - 2001, and were re-sampled as part of this remedial investigation in 2004. Figures 4-18 and 4-19 present the temporal pattern of dissolved cadmium and dissolved zinc in wells GW-15 and GW-46, respectively. Concentrations are presented in the top panel and water level elevations are presented in the bottom panel. Inspection of these lower panel reveals there is a cyclical trend to the water level elevations observed in both wells, with the highest levels typically observed in the 2nd or 3rd quarters (May/June or August/September) and the lowest levels observed in the 4th or 1st quarters (November or February). However, there is no clear time pattern or cyclical trend in the dissolved concentrations of cadmium and zinc.

Plume Delineation

Figures 4-20 and Figure 4-21 show the average concentration of cadmium and zinc in off-site groundwater wells using background (upgradient) wells as the frame of reference. That is, for the purposes of assigning color codes to each well, background is defined as a concentration that is less than or equal to the mean plus two standard deviations of the mean concentration of a chemical measured in wells PS-1, PS-3, and PS-4.

For cadmium (Figure 4-20), the extent of elevations above background appears to be limited to a small elliptical area parallel to the western margin of the South Platte alluvium. The eastern extent of off-site impacts (above background) cannot be completely determined based on the current dataset, since concentrations of cadmium in the eastern-most wells (PS-18 through PS-14) are elevated relative to background.

For zinc (Figure 4-21), the extent of elevations over background cannot be defined from the current dataset, because all of the wells downgradient of the site have mean concentrations that are higher than in the upgradient wells.

From a regulatory perspective, it is especially helpful to characterize areas where off-site groundwater is impacted at a level above federal drinking water standards (Maximum Contaminant Levels, or MCLs). Results for cadmium (MCL = 5 ug/L) are shown in Figure 4-22. This boundary was approximated from the dissolved cadmium dataset using ArcGIS Geostatistical Analyst software to estimate locations where the cadmium concentration is equal to 5 ug/L. As seen, the data were adequate for estimating the northern and southern boundaries of the 5 ug/L cadmium isocontour. The western margin of the plume was assumed to be equal to the boundary of the South Platte alluvium. However, the dataset did not provide sufficient information to reliably estimate the eastern extent of MCL exceedences. The dashed line shown in Figure 4-22 is an approximation based on the mean cadmium concentration observed at PS-16 and PS-17.

For zinc, there are no wells with a mean concentration that exceeds the Federal MCL (5,000 ug/L), so no map is required.

4.3 LOCATION OF WELLS OF POTENTIAL CONCERN

Two data sources were utilized to identify the locations of private wells within the extent of the off-site cadmium plume: (1) Colorado Division of Water Resources well data and (2) Colorado Department of Health door-to-door well survey. Each data source is briefly described below.

Colorado Division of Water Resources Database

The State of Colorado Engineer's Office maintains a database of all well permitting data received by the Division of Water Resources, including well applications and permits issued (CDWR 2007). It also includes information on the well, such as well depth, well yield, well address, and the geographic coordinates for the well. The records contained in the database go as far back as the 1800s and are updated by the Division on a quarterly basis. Database records for Denver and Adams County were purchased from the Division of Water Resources. Records

for the zip code 80216 were extracted from the database and incorporated into GIS, as the zip code 80216 contains portions of Denver and Adams counties that encompass the VBI70 OU3 site and also the estimated extent of the cadmium plume. A total of 350 records of private and commercial wells were located within the zip code 80216. These wells are shown by blue dots in Figure 4-23. More detailed data on these wells are provided in Appendix J.

Colorado Department of Health Well Survey

A door-to-door well survey was conducted by the Colorado Department of Health in 1992 as part of the preliminary assessment of the VBI70 OU3 site (CDH 1992). The survey area is shown in Figure 4-24. The survey was performed either by speaking with the residents individually or by leaving a copy of the survey at the residents door along with a pre-addressed/pre-stamped envelope. The survey identified 21 private groundwater wells within the survey area. The location of these wells are shown by pink dots in Figure 4-23. The raw survey results are provided in Appendix J.

Wells Within the Cadmium MCL-Based Plume Area

Figure 4-25 shows the location of the private wells identified during the records search and/or well survey that fall within or near the estimated extent of the off-site cadmium MCL-based plume. As seen, there are 2 wells that are located within the estimate boundaries of the cadmium plume and 1 well located near the western margin of the estimated cadmium plume.

5.0 CONTAMINANT FATE AND TRANSPORT

Inorganic chemicals are not subject to degradation or volatilization processes in a manner similar to organic contaminants, but they are subject to transformation and migration processes in both soil and water. Pathways by which chemicals in contaminated on-site media might be able to migrate to off-site locations are discussed below.

5.1 SOIL

Metals in soil are typically fairly stable, with relatively low tendency to change substantially over time. This is especially true at a site such as VBI70 OU3, where contaminants in soil have been present for many years. Migration of chemicals in surface soil to off-site locations could occur through wind-blown dispersion of contaminated soil particles, and by transport of contaminated soil particles in surface water runoff. It is likely that these processes were operative in the past (especially when the smelter was in operation). Previous investigations (USEPA 2001 and TRC 1988) have collected data that can be used to evaluate potential historical impacts from these processes in the likely directions of wind-borne transport (south and northeast). As seen in Table 5-1, concentrations of metals in off-site surface soil are apparently higher than background in a number of off-site locations. This is consistent with the hypothesis that off-site releases may have occurred from OU3, but it is important to note that there are several other sources besides OU3 that could also be responsible for the background exceedences, including application of lawn care products and releases from other smelters or industrial sources in the area. Regardless of source, the frequency of locations that exceed a level of potential health concern is relatively low, especially based on the predominant current land use (commercial), and any off-site areas of current human health concern have been or will be addressed by these other investigations. Under present site conditions, the dispersion of contaminants by air or surface water run-off is largely prevented by the buildings and paved areas of the site, so these processes are not likely to be operating currently. However, these pathways could become relevant in the future if significant areas of contaminated soil were to become uncovered.

5.2 GROUNDWATER

5.2.1 Potential Routes of Migration

Contaminants in on-site surface and subsurface soils may migrate into groundwater under two possible scenarios: a) leaching due to infiltration of surface water (from rainfall or snowmelt), or b) direct contact of groundwater with contaminated soil or waste material (from fluctuations of the water table). Currently, infiltration of water from rainfall at the site is restricted by the limited amount of pervious surface at the site, and is unlikely to be a significant transport process at present. However, this could become an important pathway in the future, if significant areas of soil were uncovered. Direct contact of buried waste with groundwater could occur, although the limited site-specific data that are available suggest that groundwater beneath the site is usually absent or present in very small amounts, so contact of buried wastes due to a rising water table appears to be relatively unlikely.

Contaminants that do become dissolved in groundwater have the potential to move either vertically (towards deeper aquifers) and/or horizontally (downgradient from the site). As noted in the soil borings (Appendix B), most of the site is underlain by bedrock claystone that serves as a barrier between the shallow and the deep regional aquifers, largely preventing groundwater from migrating downward. Thus, the main concern at the site is the potential for lateral migration of contaminated on-site water to off-site locations east (downgradient) of the site. However, as described in a technical memorandum on the construction of the Interstate-25 interchange (see Appendix I), lateral migration of contaminants from the terrace alluvium underlying the site is largely cut off by the construction of the retaining walls keyed into the underlying bedrock outcrop (Knight Piesold 2005b).

An alternative model to the lateral migration of chemicals is desorption of contaminants historically deposited in the alluvial sediments of the Platte Valley alluvium by lateral migration of contaminants in groundwater (prior to the construction of I-25). Surface water flows that overtopped or transected the bedrock outcrop through channels of sandstone incised in the Denver Formation claystone could have also contributed to historical contamination of sediments in the Platte Valley alluvium (Knight Piésold 2006).

5.2.2 Characterization of Contaminant Migration in Groundwater

The rate and extent of contaminant migration in groundwater is a complex function of many variables. The equilibrium between metals bound to soil particles and dissolved in pore water is described by the chemical specific soil/water partition coefficient (K_d). This coefficient is influenced by a number of soil conditions such as pH, oxidation-reduction conditions, iron oxide content, soil organic matter content, cation exchange capacity, major ion chemistry and availability of charged sites on soil surfaces (USEPA 1996b, 2003c). Mathematical models that utilize metal-specific K_d values along with knowledge of site-specific soil properties and groundwater flow regimes are sometimes used to estimate the extent of groundwater contamination from contaminated soils and the subsequent rate of migration of contaminants with the groundwater flow. At this site, quantitative modeling has not been attempted due to the very limited occurrence of groundwater, uncertainty in the direction and magnitude of local gradients, the unusual nature of the soil material (largely fill and debris), and the apparent complexity of the underlying hydrogeology. However, a qualitative evaluation of the potential for contaminant migration in groundwater can be derived from the available data on chemical concentration values and the appearance of groundwater at various locations on site and a semi-quantitative, screening-level estimates of chemical migration from the site, as follows.

First, it is evident form the site data that the primary source for groundwater contamination is the perched groundwater in the area of the former smelter (especially near SB-04 and SB-07). As discussed in USEPA (2004b), there is no evidence that groundwater flow is presently occurring from the perched system beneath the former smelter site. The monitoring to date has not found evidence for hydraulic connection between the perched zone and the discontinuous shallow groundwater further to the east. Such evidence would include identification of a continuous water table or correlated variations in water levels. Conceptually, it can be proposed that small volumes of groundwater are currently migrating east from the perched system to the lower saturated zone, and then further east to the site boundary, but the exact pathways have not been identified. For example, the pathway cannot be through MW-32 because the saturated zone at MW-33 and MW-34 developed before groundwater appeared at MW-32. Similarly, very small (less than a liter per day) volumes of water are known to appear at MW-36 (Section 4.2), but a larger volume pathway escaping the saturated zone cannot be ruled out (USEPA 2004b). An

alternative conceptual model is to propose that the current pattern of groundwater contamination is the result of historic conditions and flows, and that transport is no longer occurring between the perched aquifer and the alluvial aquifer to the east. Further data would be required to distinguish between these models. However, in either case, the data available support the conclusion that groundwater flow emanating from the site is limited in extent, and this in turn limits the likely extent of off-site migration of contaminant in site water, at least under present conditions.

Screening level calculations of metal loading to, and the resulting incremental concentrations in, the South Platte River from the VBI70 OU3 site, under current conditions (paved, current concentrations in groundwater) are presented in Appendix I. For cadmium, mass loads to the South Platte River from the off-site plume range from 0.013 - 0.036 mg/sec. Zinc loads are higher, ranging from 0.033 - 0.130 mg/sec. If this load were discharged to the South Platte River, the resulting incremental concentrations in the South Platte River are likely to be small (0.006 - 0.11 ug/L for cadmium and 0.016 - 0.4 ug/L for zinc).

6.0 BASELINE RISK ASSESSMENT

The USEPA conducted a baseline human health and screening level ecological risk assessment (USEPA 2006) to assess the potential risks to human and ecological receptors, both now and in the future, from site-related contaminants present in environmental media at the VBI70 OU3 Site. The risk assessment assumes that no steps are taken to remediate the environment or to reduce contact by human or ecological receptors with contaminated environmental media. The results of this assessment are intended to help inform risk managers and the public about potential human and ecological risks attributable to site-related contaminants and to help determine if there is a need for action at the site (USEPA 1989).

6.1 ENVIRONMENTAL DATA USED IN THE RISK ASSESSMENT

As discussed in Section 3.1, environmental data at or in the vicinity of the VBI70 OU3 Site are available from the following sources: (1) the Globe Plant Remedial Investigation (TRC 1988); (2) quarterly monitoring of Globe Plant Wells GW-15 and GW-46 (Envirogroup 2004), and (3) the VBI70 OU3 Phase I Remedial Investigation. Soil data collected from 1987-1988 during the Globe Remedial Investigation (6 soil samples from 3 locations) were not selected for use in the risk assessment because sufficient data on the current condition of metals in surface and subsurface soils (123 samples) were available from the VBI70 OU3 Remedial Investigation. Because of the limited amount of groundwater data available, groundwater data from the Globe Remedial Investigation and quarterly monitoring of Globe Plant monitoring wells GW-15 and GW-46 were selected for use in the risk assessment to better approximate the long term average concentration of metals in groundwater at each well. All of the raw analytical data from the Phase I Investigation of the VBI70 OU3 Site were found to have adequate data quality (see Sections 3.4.1 and 3.4.2) and were determined suitable for use in risk assessment.

6.2 EXPOSURE ASSESSMENT

6.2.1 Site Conceptual Model

Figures 6-1 and 6-2 present site conceptual models showing how chemicals that may have been

released from the former Argo Smelter might result in exposure of human or ecological receptors, respectively. However, not all of these potential exposure routes are likely to be of equal concern. Exposure scenarios that are considered to be complete and potentially significant are shown by boxes containing a solid black circle. Pathways that are judged to be complete but which are likely to contribute only occasional or minor exposures are shown by boxes with an "X". Incomplete pathways (i.e., those which are not thought to occur) are shown by open boxes.

6.2.2 Selection of Pathways for Evaluation

Human Health

As seen in Figure 6-1, several potential exposure pathways were identified for commercial workers, construction workers and residents. However, not all of these pathways are likely to be of equal concern. Pathways that were considered to be most likely to be significant and which were retained for quantitative evaluation included:

Location	Exposure Medium	Exposed Receptors	Exposure Route
On-site	Soil (surface and subsurface)	Future commercial workers, current/future construction workers	Incidental ingestion
	Groundwater	Future commercial workers, future residents	Ingestion
Off-site	Groundwater	Future residents	Ingestion

Pathways that were judged to be minor and/or below a level of potential concern and thus the pathways were not retained for further evaluation in the risk assessment included inhalation of particulates, dermal exposure to soil or water, ingestion of garden vegetables or incidental ingestion of garden soil, and ingestion of off-site surface soil.

Ecological

As shown in Figure 6-2, urban wildlife, aquatic receptors and plants were considered as potential ecological receptors that may be exposed to site-related contaminants. Because nearly the entire

site is covered with pavement or buildings, there is very little usable habitat or food supply available and consequently, the probability of wildlife receiving significant exposures at the site is considered to be negligible. Therefore, risks to wildlife were not evaluated quantitatively. Likewise, because there are no permanent surface water bodies located on the site, there are no complete exposure pathways for on-site aquatic receptors. Exposure of off-site aquatic receptors could be of concern if contaminated groundwater from the site discharges into the South Platte River. However, even if this pathway is complete, screening level calculations (see USEPA 2006, Appendix D) indicate releases of contaminants into surface water from groundwater recharging to the South Platte River are likely to be small and are likely to result in very small changes in concentrations in the river. For these reasons, risks to aquatic receptors were not evaluated quantitatively. Although there is no significant plant growth at the site at present, some property owners might, in the future, wish to develop landscaped areas to allow plant growth (grass, shrubs, trees, etc), so exposures of plants to contaminants in on-site surface soil could be of potential concern in the future and was evaluated quantitatively in this assessment. Likewise, irrigation of off-site gardens with contaminated groundwater could result in phytotoxicity, and this pathway was also evaluated quantitatively. These pathways are summarized below:

Location	Exposure Medium	Exposed Receptors	Exposure Route
On-site	Soil (surface and subsurface)	Future plants	Direct contact
Off-site	Irrigated garden soil	Current/future plants	Direct contact

6.2.3 Chemicals of Potential Concern

Human Health

Chemicals of Potential Concern (COPCs) are chemicals which exist in the environment at concentration levels that might be of potential health concern to humans and which are or might be derived, at least in part, from site-related sources. COPCs for the human health risk assessment were selected at the site using a conservative screening procedure that is intended to ensure that any chemical of plausible health concern is retained for evaluation. Figure 6-3

summarizes the COPC selection process and Table 6-1 lists the COPCs identified for quantitative evaluation by the human health risk assessment at this site.

Ecological

A COPC screen was not conducted for ecological receptors (terrestrial plants). Instead, risks were evaluated from all chemicals for which data were available.

6.2.4 Quantification of Human Exposure (Non-Lead COPCs)

Human Exposure Estimates

Risk from a chemical contaminant is related to the level of exposure or contact with the chemical. For every exposure pathway of potential concern, it is expected that there will be differences between different individuals in the level of exposure at a specific location due to differences in intake rates, body weights, exposure frequencies, and exposure durations. Thus, there is normally a wide range of average daily intakes between different members of an exposed population. Because of this, all daily intake calculations must specify what part of the range of doses is being estimated. Typically, attention is focused on intakes that are "average" or are otherwise near the central portion of the range, and on intakes that are near the upper end of the range (e.g., the 95th percentile). These two exposure estimates are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME), respectively.

All estimates of CTE and RME exposure were calculated in accord with current USEPA guidance (1989, 1991a, 1993, and 2002) for quantification of exposure. Exposure parameters were based on national default values or professional judgement whenever reliable site data were not available.

Selection of Exposure Points

An exposure point (also referred to as an exposure unit or exposure area) is an area where a receptor (commercial worker, construction worker or resident) may be exposed to one or more environmental media. Because the concentration of metals in soil and groundwater may vary

from location to location, and because each sampling location represents are area where a receptor might be exposed, each sampling station was evaluated as an individual exposure point for soil or groundwater. For soil, each depth stratum at each sampling location was also evaluated individually. For the uppermost soil stratum (surface soil), this represents an exposure that would occur if the man-made cover were removed. For subsurface soils, this represents a hypothetical exposure that might occur if future excavation activity brought subsurface soil to the surface. Risks from groundwater were evaluated on a well-by-well basis because the concentrations of metals in groundwater vary from well to well, and thus exposure and risk from metals in groundwater will vary depending on the precise location where a hypothetical future drinking water well might be installed.

Calculation of Exposure Point Concentrations (EPCs)

In general, the exposure point concentration (EPC) for an exposure area is the 95th upper confidence level (UCL) of the average concentration or the maximum detected concentration (whichever is smallest). For soil, because only one sample is available for each exposure point (borehole/depth), a 95th UCL could not be calculated and the EPC was simply taken to be the concentration in each sample. For groundwater, EPCs were calculated for each well. If the COPC was not detected, the EPC was taken to be one-half the detection limit for that COPC at that location. Rejected (R-qualified) data were not used when calculating an EPC.

6.2.5 Evaluating Human Exposure to Lead

Overview

Risks from lead are evaluated using a somewhat different approach than for most other chemicals. In brief, mathematical models are used to estimate the distribution of blood lead values in a population of people exposed to lead under a specified set of conditions. Health risks are judged to be acceptable if there is no more than a 5% chance that an exposed individual (a child or a woman of child-bearing age) will have a blood lead level that exceeds 10 µg/dL. For convenience, this probability is referred to as P10.

Adult Lead Exposure Model

The approach described by Bowers et al. (1994) has been identified by USEPA's Technical Workgroup for Lead (USEPA 1996b and 2003b) as a reasonable interim methodology for assessing risks to adults from exposure to lead and for establishing risk-based concentration goals that will protect older children and adults from lead. For this reason, this method was used for estimating exposure to current or future commercial workers and construction workers, to lead in soil. When adults are exposed, the sub-population of chief concern is pregnant women and women of child-bearing age, since the blood lead level of a fetus is nearly equal to the blood lead level of the mother (Goyer 1990).

Adult Lead Model Exposure Parameters

All of the exposure values for contact with site media are the same as the CTE exposure parameters assumed for other chemicals, and most of the biokinetic model parameters are the defaults recommended by USEPA (1996b and 2003b). The baseline blood lead value and geometric standard deviation are derived from data reported by the National Health and Nutrition Evaluation Survey (NHANES III) (USEPA 2002) for women in the West Census region, aged 17-45 (Table 3c). While, USEPA (1996b and 2003b) recommends using the average lead concentration at an exposure area as the EPC in the model, the concentration of lead at each exposure point (borehole) was used, instead, since only one sample was available at each exposure point.

6.3 TOXICITY ASSESSMENT

6.3.1 Human Health

Non-Cancer Effects

For non-cancer effects, the key toxicity parameter is the dose at which an adverse effect first becomes evident. Doses below this "threshold" are considered to be safe, while doses above the threshold are likely to cause an effect. Based on a thorough review of all available data, EPA identifies a Reference Dose (RfD) to be used as a conservative estimate of the threshold. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Cancer Effects

For cancer effects, the toxicity assessment process has two components. The first is a qualitative evaluation of the weight of evidence (WOE) that the chemical does or does not cause cancer in humans. For chemicals which are considered known or possible human carcinogens, the second part of the toxicity assessment is to describe the carcinogenic potency of the chemical. This is done by quantifying how the number of cancers observed in exposed animals or humans increases as the dose increases. Typically, it is assumed that the dose response curve for cancer has no threshold, arising from the origin and increasing linearly until high doses are reached. Thus, the most convenient descriptor of cancer potency is the slope of the dose-response curve at low doses (where the slope is still linear). This is referred to as the Slope Factor (SF), which has dimensions of risk of cancer per unit dose.

Toxicity Values

Toxicity values (RfD and SF values) are often estimated by a variety of different groups or agencies. USEPA (2003d) describes the recommended hierarchy for selecting toxicity values for use in human health risk assessment at Superfund sites. The first preference is for USEPA

consensus values as listed in the Integrated Risk Information System (IRIS), an electronic database containing human health assessments for various chemicals. If values are not available from IRIS, the next preference is to seek Provisional Peer Reviewed Toxicity Values for Superfund (PPRTVs) developed by EPA's Superfund Health Risk Technical Support Center (STSC). If PPRTVs are not available, toxicity values may be obtained from other sources, such as the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), California EPA's Toxicity Criteria Database, and USEPA's Health Effects Assessment Summary Tables (HEAST) (USEPA 1997c). Most of these values are also compiled in the Risk-Based Concentration tables developed and maintained by USEPA Region III (USEPA 2005b).

The toxicity values used for evaluation of human health risks from quantitative COPCs at this site were selected in accordance with USEPA (2003d).

Health-Based Goal for Lead

It is currently difficult to identify what degree of lead exposure, if any, can be considered safe for infants and children. After a thorough review of available data, the USEPA identified 10 µg/dL as the concentration level at which effects begin to occur that warrant avoidance, and has set as a goal that there should be no more than a 5% chance that a child will have a blood lead value above 10 µg/dL (USEPA 1991c and 1994). Likewise, the Centers for Disease Control (CDC) has established a guideline of 10 µg/dL in preschool children which is believed to prevent or minimize lead-associated cognitive deficits (CDC 1991). By analogy, a value of 10 µg/dL is also generally applied to a fetus *in utero*. For convenience, the probability of a blood lead value exceeding 10 µg/dL is referred to as P10.

6.3.2 Ecological Receptors

Toxicity values for the protection terrestrial plant from contaminants in soils were selected from two different sources: Ecological Soil Screening Levels (Eco-SSLs) for Plants developed by USEPA (2003c) and soil toxicity data for plants developed by Oak Ridge National Laboratory (ORNL) (Efroymson et al. 1997). When an appropriate toxicity value was provided in each source, Eco-SSL values were preferred to ORNL values.

6.4 RISK CHARACTERIZATION

6.4.1 Risks to Humans

Basic Approach for Characterizing Non-Cancer Risks

For most chemicals (except lead), the potential for non-cancer effects is evaluated by comparing the estimated daily intake of the chemical over a specific time period with the RfD for that chemical derived for a similar exposed period. This comparison results in a non-cancer Hazard Quotient (HQ), as follows:

$$HQ = DI / RfD$$

where:

HQ	=	Hazard Quotient
DI	=	Daily Intake (mg/kg-day)
RfD	=	Reference Dose (mg/kg-day)

If the HQ for a chemical is equal to or less than one, it is believed that there is no appreciable risk that non-cancer health effects will occur. If an HQ exceeds one, there is some possibility that non-cancer effects may occur, although an HQ above one does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all RfD values. However, the larger the HQ value, the more likely it is that an adverse effect may occur.

If an individual is exposed to more than one chemical, a screening-level estimate of the total non-cancer risk is derived simply by summing the HQ values for that individual. This total is referred to as the Hazard Index (HI). If the HI value is less than one, non-cancer risks are not expected from any chemical, alone or in combination with others. If the screening level HI exceeds one, it may be appropriate to perform a follow-on evaluation in which HQ values are added only if they affect the same target tissue or organ system (e.g., the liver). This is because chemicals which do not cause toxicity in the same tissues are not likely to cause additive effects.

In the case of lead, risks are evaluated using a mathematical model (USEPA 1996b and 2003b) to estimate the distribution of blood lead values in a population of people exposed to lead under a specified set of conditions. Health risks are judged to be acceptable if there is no more than a 5% chance that an exposed individual (a child or a woman of child-bearing age) will have a blood lead level that exceeds 10 µg/dL. For convenience, this probability is referred to as P10.

Basic Approach for Characterizing Cancer Risks

The excess risk of cancer from exposure to a chemical is described in terms of the probability that an exposed individual will develop cancer because of that exposure by age 70. For each chemical of concern, this value is calculated from the daily intake of the chemical from the site, averaged over a lifetime (DI_L), and the slope factor (SF) for the chemical, as follows (USEPA 1989):

$$\text{Excess Cancer Risk} = 1 - \exp(-DI_L \cdot SF)$$

Excess cancer risks are summed across all chemicals of concern and all exposure pathways that contribute to exposure of an individual in a given population.

The level of total cancer risk that is of concern is a matter of personal, community, and regulatory judgement. In general, the USEPA considers excess cancer risks that are below about 1 in 1,000,000 to be so small as to be negligible, and risks above 1 in 10,000 to be sufficiently large that some sort of remediation is desirable. Excess cancer risks that range between 1 in 1,000,000 to 1 in 10,000 are generally considered to be acceptable, although this is evaluated on a case by case basis.

Risk Estimates from Ingestion of Soil

Commercial Worker

The estimated non-cancer and cancer risks to a current or future commercial worker from incidental ingestion of non-lead chemicals in soil are presented in detail in Table 6-2. As seen, both CTE and RME non-cancer and cancer risks are at or below EPA's typical level of concern

in all cases (i.e., non-cancer HI < 1 and cancer risk < 1 in 10,000), with the exception of a sample collected at 10-12 feet below ground surface at Station 7. At this location, CTE and RME non-cancer and RME cancer risks would be above a level of concern to commercial workers if the soil were excavated, brought to the surface, and left uncovered due to the elevated concentration of arsenic.

The spatial distribution of the estimated RME non-cancer and cancer risks for commercial workers is presented in Figures 6-4 and 6-5, respectively. As seen, non-cancer risks are below EPA's level of concern (HI < 1) and cancer risks are within or below EPA's risk range (1E-04 to 1E-06) at all locations except one (Station 7). At this location, the concentration of arsenic in subsurace soil at the 10-12 foot depth exceeds both a non-cancer and a cancer level of concern.

Table 6-3 summarizes the estimated risk to current or future commercial workers from exposure to lead in soil. As seen, the probability that a female worker will have a blood lead value that could be of concern to a fetus (P10 > 5%) is well below USEPA's health-based goal at all locations, except for the soil sample from 10-12 feet below surface at Station 7. If soil from this location were brought to the surface, the estimated probability of a commercial worker having an exposure that would result in a fetal blood lead value above 10 µg/dL is about 6%, which is slightly in excess of EPA's goal (P10 < 5%).

Construction Worker

The estimated non-cancer and cancer risks to current or future construction workers from incidental ingestion of non-lead chemicals in soil are presented in Table 6-4. Similar to the findings for a commercial worker, both CTE and RME non-cancer risks are at or below a level of concern in all cases (i.e., HI < 1) for a current or future construction worker, with the exception of a sample collected at 10-12 feet below ground surface at Station 7. At this location, RME non-cancer risks would be above a level of concern due to the concentration of arsenic. For cancer, both CTE and RME estimated risks are within or below USEPA's usual target risk range for a current or future construction worker at all locations. The spatial pattern of RME cancer risks to a construction workers is shown in Figure 6-6.

Table 6-5 summarizes the estimated risk to construction workers from exposure to lead in soil. As seen, at all locations the probability that a female worker will have a blood lead value that could be of concern to a fetus is well below USEPA's health-based goal.

In interpreting these results, it is important to consider the likelihood that soil from the 10-12 foot depth at Station 7 would be brought to the surface and distributed in an undiluted (un-mixed) fashion. While theoretically possible, it is much more likely that if soil from this depth were brought to the surface, it would be mixed with soils from other depths as well as with soil that is presently at the surface. If so, this mixing would be expected to decrease the concentration value of lead and arsenic in the soil, and risks would therefore be lower than calculated. For example, if all soils from 0 to 12 feet at Station 7 were mixed, the resulting concentrations would be about 2-fold lower for lead and 8-fold lower for arsenic than concentrations of lead and arsenic 10-12 feet bgs. Under this scenario, soil levels would be below a level of concern for lead, but might still be still above a level of concern for arsenic.

Risk Estimates from Ingestion of Groundwater

Estimated risks to commercial workers, on-site residents, and off-site residents from hypothetical future groundwater ingestion are presented in Tables 6-6 through 6-10. Results are presented for two different exposure scenarios: (1) ingestion of unfiltered well water (risks from total recoverable metals) and (2) ingestion of filtered well water (risks from dissolved metals).

Commercial Workers

For non-lead COPCs in groundwater, both CTE and RME non-cancer risks are above a level of concern (HI > 1) for future commercial workers under both exposure scenarios (filtered and unfiltered) at several locations. Risks are mostly due to elevated levels of cadmium and manganese, with smaller contributions from arsenic. At Station 7, non-cancer risks from filtered water are attributed primarily to manganese and arsenic, whereas risks from unfiltered water are primarily attributable to arsenic and cadmium, with smaller contributions from copper, manganese, mercury, thallium, vanadium, and zinc. Figure 6-7 summarizes the locations that are above EPA's typical level of concern for RME non-cancer risks (HI > 1) from ingestion of both filtered and unfiltered groundwater.

Estimated cancer risks for commercial workers are within USEPA's target risk range at all locations for both exposure scenarios (filtered and unfiltered), with the exception of Station 7. At Station 7, RME cancer risks exceed the upper end of the risk range (1 in 10,000) for both scenarios and CTE cancer risks exceed the upper end of USEPA's target risk range for the unfiltered scenario. All cancer risks are attributable to arsenic in groundwater. The spatial pattern of RME cancer risks from filtered and unfiltered groundwater are presented in Figures 6-8 and 6-9, respectively.

As shown in Table 6-7, risks from lead in groundwater were evaluated by comparing measured lead concentrations to the federal drinking water action level (15 µg/L). Dissolved levels of lead are well below the federal action level at all locations, indicating that ingestion of filtered water would not be of concern. However, total levels of lead exceed the federal action level at several locations, indicating that consuming unfiltered groundwater would pose an unacceptable risk to commercial workers at some locations (see Figure 6-10).

Hypothetical Future On-Site Residents

Table 6-8 shows risk to hypothetical future on-site residents from non-lead COPCs in groundwater, assuming the shallow aquifer might be used for drinking water (this is not considered likely). As seen, both non-cancer and cancer risks are higher for future residents than for workers (Table 6-6) due to higher long term intake by residents than workers. CTE and RME non-cancer risks are above a level of concern (i.e., HI > 1) under both exposure scenarios (filtered and unfiltered) at most locations. Chemicals contributing to non-cancer risks are the same as those contributing to non-cancer risks for commercial workers (mainly cadmium, manganese, and arsenic at most stations with additional contributions from total levels of copper, manganese, mercury, thallium, vanadium, and zinc at Station 7). RME non-cancer risk estimates from filtered and unfiltered groundwater are presented in Figures 6-11 and 6-12, respectively. RME cancer risks exceed the upper end of EPA's target risk range at several locations for both unfiltered and filtered groundwater, whereas CTE cancer risks exceed the upper end of EPA's target risk range for unfiltered groundwater at one location (Station 7). All cancer risks are attributed to total and dissolved arsenic concentrations. RME cancer risk estimates from filtered and unfiltered groundwater are presented in Figures 6-13 and 6-14, respectively.

As with commercial workers, concentrations of lead in filtered groundwater are lower than the federal action level of 15 µg/dL for lead and thus, below a level concern to off-site residents if the groundwater was ever consumed in the future (see Table 6-7 and Figure 6-10). However, lead concentrations in unfiltered groundwater exceed the federal action level and would pose an unacceptable risk to residents if it were used for drinking.

Off-Site Residents (Hypothetical Future Use of Groundwater for Drinking)

Table 6-9 shows risks to off-site residents from hypothetical future ingestion of non-lead COPCs in groundwater, based on the assumption the shallow aquifer would be for drinking water (this is not considered likely). As seen, CTE and RME non-cancer risks are above a level of concern (HI > 1E+00) under both exposure scenarios (filtered and unfiltered) at most locations. Risks are mostly due to elevated levels of cadmium, with contributions from other chemicals such as arsenic, manganese, thallium vanadium and iron at some locations. For a sub-set of wells (PS-1, PS-3, PS-4 and PS-5) non-cancer risks for the unfiltered exposure scenario are primarily attributed to iron with smaller contributions from manganese and vanadium. RME non-cancer risk estimates from filtered and unfiltered groundwater are presented in Figures 6-11 and 6-12, respectively.

As seen in the upper half of Table 6-9, estimated cancer risks for off-site residents from filtered groundwater are within USEPA's target risk range (1E-04 to 1E-06) at most locations, with the exception station BH-12 and GW-17. At these locations, RME cancer risks exceed the upper end of USEPA's target risk range (1E-04) due to the concentration of arsenic in groundwater. Estimated cancer risks for off-site residents from unfiltered groundwater are presented in the lower half of Table 6-9. As seen, estimated cancer risks exceed USEPA's target risk range (1E-04 to 1E-06) at several locations due to the concentration of total arsenic in groundwater. RME cancer risk estimates from filtered and unfiltered groundwater are presented in Figures 6-13 and 6-14, respectively.

Risks from lead in groundwater were evaluated by comparing measured lead concentrations to the federal drinking water action level (15 g/L). As seen in Table 6-10, dissolved levels of lead in groundwater are well below the federal action level at all locations. However, levels of total lead in groundwater are above the action level at several locations (Table 6-10 and Figure 6-10).

Based on this, lead in filtered groundwater is not of concern to off-site residents, but at some locations consuming unfiltered groundwater would pose an unacceptable risk.

6.4.2 Risks to Ecological Receptors

Basic Approach

The method used to characterize risks to terrestrial plants is similar to the HQ method used to characterize non-cancer risks to humans. That is, the concentration of each COPC in soil is compared to an appropriate Toxicity Reference Value (TRV), and the ratio is the HQ. If the HQ for a chemical is equal to or less than 1, risks to plants are expected to be below a level of concern. If an HQ exceeds 1, it is possible that some types of plants may experience decreases in germination, growth, or survival. Although it is not possible to quantify the magnitude or severity of the effects from the HQ value alone, the larger the HQ value the more likely it is that adverse effects will occur.

Results for On-Site Plants

The estimated HQ values for each site sample (grouped by depth) are presented in detail in Table 6-11. In addition, the HQ value based on average background concentrations near the site is also provided for reference. Inspection of this table reveals the following main points:

- Estimated HQs for barium, chromium, manganese, vanadium, and zinc exceed 1 for the reference soil. This indicates that the toxicity benchmarks for these chemicals are likely to be overprotective for this site, and hence HQ values greater than 1 for these chemicals in site samples should be interpreted as uncertain.

- For chemicals where the background HQ does not exceed 1 (antimony, arsenic, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium), most HQ values for site soils are below 1 in both surface and subsurface soils, but there are scattered samples with HQ values above 1. The frequency of these samples is summarized in Table 6-12. As seen, most exceedences are relatively small (HQ = 1-2), although some larger exceedences are observed (especially for copper).

- The largest exceedences tend to occur at depth in the vicinity of Station 7, with the frequency and magnitude of exceedences tending to be low for samples collected at stations around the perimeter of the site (Stations 28-37).

These calculations indicate that levels of copper and perhaps a few other metals in soils from the former smelter area may be within range of potential phytotoxicity in some locations. Because most of the former smelter and surrounding areas are presently covered with buildings and paved parking lots, these predicted risks are not currently of concern, but could be of concern if soils become exposed and subsurface materials were brought to the surface. In this event, because of the uncertainty in most plant TRVs for metals, further testing would be needed to confirm these predictions.

Results for Off-Site Plants in Irrigated Gardens

Calculations of the potential phytotoxic effect of irrigation of garden soils with contaminated groundwater are presented by well in Appendix C (Table C-5) of the risk assessment report (USEPA 2006). Table 6-13 summarizes the results by chemical across all locations. As seen in these tables, these calculations suggest that 8 chemicals could be of potential phytotoxic concern (total concentration > SSL) after 70 years of irrigation, including barium, chromium, manganese, selenium, silver, thallium, vanadium and zinc. Note, however, that for four of these chemicals (chromium, manganese, thallium, and vanadium), background concentrations in soil also exceed the SSL. This suggests that the SSL values for these chemicals may be somewhat conservative, since phytotoxicity is generally not expected in background soil. Thus, it is in uncertain whether the effect of irrigation will actually cause phytotoxicity or not (at least for these four chemicals), and further testing would be needed to investigate this issue.

6.5 UNCERTAINTIES

Quantitative evaluation of the risks to humans and ecological receptors from environmental contamination is frequently limited by uncertainty regarding a number of key data items, including concentration levels in the environment, the true level of contact with contaminated media, and the true dose-response curves for adverse effects. This uncertainty is usually addressed by making assumptions or estimates for uncertain parameters based on whatever

limited data are available. Because of these assumptions and estimates, the results of risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment.

Table 6-14 identifies the main sources of uncertainty in the risk evaluations performed in this assessment, along with the likely direction of any errors (under- or over-estimation of risks), and a rough estimate of the likely magnitude of the under- or over-estimation. As seen, some uncertainties will tend to lead to an underestimate of risk, but these underestimates are thought to be relatively small. A number of uncertainties are likely to lead to an overestimate of risk, and in some cases, these overestimates might be moderate to large. Based on this, the risk estimates derived in this risk assessment are more likely to overestimate than underestimate risk.

7.0 SUMMARY AND CONCLUSIONS

7.1 ON-SITE SOIL

Nature and Extent of Contamination in On-Site Soil

Concentrations of numerous metals in soils in the area of the former smelter site are greater than background concentrations typically expected for the region. This includes arsenic, cadmium, copper, lead and zinc, and to a lesser extent, iron, manganese, mercury, nickel, selenium and silver. One localized area of especially high contamination was identified near the center of the site (Station 7) at a depth of 10-12 feet. These data indicate that site soils were contaminated by operations at the former smelter.

Fate and Transport of Contaminants in On-Site Soil

Migration of smelter-related contaminants in surface soil to off-site locations could occur through wind-blown dispersion of contaminated soil particles, and by transport of contaminated soil particles in surface water runoff. It is likely that these processes were operative in the past (especially when the smelter was in operation). While other investigations have detected concentrations of some metals above background in off-site soils near OU3, few of these exceed a level of concern to humans, and all locations that are of potential concern have been or will be addressed by these other investigations. Under present site conditions, the dispersion of contaminants by air or surface water run-off is largely prevented by the buildings and paved areas of the site. However, these pathways could become relevant in the future if significant areas of contaminated soil were to become uncovered.

Estimated Risks to Human Receptors from On-Site Soil

At present, most of the site is covered with buildings or paved parking lots, and human contact with site soils is likely to be minimal except for construction workers engaged in on-site excavations. If exposure were to occur, the estimated non-cancer and cancer risks to current or

future commercial workers and construction workers from incidental ingestion of non-lead chemicals in soil are at or below EPA's typical level of concern in all cases (i.e., non-cancer HI < 1 and cancer risk < 1 in 10,000) with the exception of the sample collected at 10-12 feet below ground surface at Station 7. At this location, non-cancer risks would be above a level of concern to both commercial workers and construction workers and cancer risks from arsenic would be above a level of concern to commercial workers if the soil were excavated, brought to the surface, and left uncovered.

For exposure to lead in soil, the probability that a female commercial worker will have a blood lead value that could be of concern to a fetus (P10 > 5%) is well below USEPA's health-based goal at all locations, except for the soil sample from 10-12 feet below surface at Station 7. If soil from this location were brought to the surface, the estimated probability of a commercial worker having an exposure that would result in a fetal blood lead value above 10 μg/dL is about 6%, which is slightly in excess of EPA's goal (P10 < 5%). For current or future construction workers, the probability that a female worker will have a blood lead value that could be of concern to a fetus (P10 > 5%) is well below USEPA's health-based goal at all locations.

The likelihood that soil from the 10-12 foot depth at Station 7 would be brought to the surface and distributed in an undiluted (un-mixed) fashion is considered to be relatively low. Rather, if soil from this depth were brought to the surface, it would likely be mixed with soils from other depths as well as with soil that is presently at the surface, decreasing the concentrations of metals and therefore lowering the estimated risks.

Estimated Risks to Ecological Receptors from Contaminants in On-Site Soil

At present, there is very little habitat available for plant or wildlife species at the site, so the potential for exposure of ecological receptors at the site is low. In the future, if some areas of land were exposed, levels of copper and perhaps a few other metals in soils may be within range of potential phytotoxicity in some locations. However, these conclusions should be considered uncertain due to uncertainty in available plant phytotoxicity values for metals.

Conclusions Regarding On-Site Soil

Although the concentrations of a number of metals appear to elevated above background in site soils, concentrations are below a level of human heath concern at all sampling locations except one (a subsurface sample from near the center of the site). Exposure to this soil is not considered to be likely. Levels of some chemicals might be above a level of phytotoxicity in some locations, but this is uncertain. Overall, the level of concern for site soils is low.

7.2 SHALLOW GROUNDWATER

Nature and Extent of Contamination in Shallow Groundwater

On-Site Groundwater

Under current site conditions, there is very little shallow groundwater present below the site. Small pockets of perched water occur in the area of the former smelter facility, and a discontinuous shallow groundwater exists in the eastern portion of the site. Elevated levels of multiple metals were observed in samples of the perched groundwater collected from within the historical footprints of former smelter buildings, with some (arsenic, cadmium, iron, manganese, thallium, and zinc) exceeding drinking water standards. Concentrations of metals tend to decrease in samples from the discontinuous aquifer east of the former smelter, with most chemicals falling below MCL values except for cadmium and manganese.

Off-Site Groundwater East of the Site

Based on an inspection of spatial patterns of contaminants in off-site groundwater in the South Platte alluvium east (downgradient) of the site, it appears that historical and/or current releases of site-related contaminants may have caused elevations above background for a number of chemicals. The clearest evidence is for cadmium and zinc, but may include some other chemicals as well (e.g., arsenic, lead, iron and potassium). The extent of the cadmium concentrations that exceed background appears to be characterized by an oval plume running to the northeast, parallel to the terrace that bounds the alluvium on the west. The precise bounds of this plume for cadmium are uncertain (especially along the eastern margin) due to the limited

groundwater data collected at off-site locations. The extent of zinc contamination appears to be generally similar, but somewhat more widespread.

Fate and Transport of Contaminants in Shallow Groundwater

Currently, because the site is largely capped with buildings or pavement, infiltration of water from rainfall or snowmelt into site soils is likely to be low, and hence the potential for leaching of metals from site soils into shallow groundwater is also low. Leaching from soil into shallow groundwater could become an important pathway in the future if significant changes were made to the amount of impervious area at the site.

Most of the site is underlain by bedrock claystone that serves as a barrier between the shallow and the deep regional aquifers, largely preventing any groundwater that does occur at the site from migrating downward. Thus, the main concern at the site is the potential for lateral migration of contaminated on-site water to off-site locations east (downgradient) of the site. Although data are limited, because of the low potential for infiltration and the small amount of water detected in on-site locations, it is considered likely that the potential for off-site transport of contaminants in groundwater is low. Screening level flux calculations estimate that migration may range from 1.1 to 24 cubic feet per day (USEPA 2004b and 2004c).

Estimated Future Risks to Human Receptors from Shallow Groundwater

Estimated Future Risks to Human Receptors from Shallow Groundwater Beneath the Site

Under present site conditions, water from shallow groundwater beneath the site is not used for drinking. If the water ever were used for drinking in the future (this is not considered likely), both cancer and non-cancer risks would be above a level of concern (non-cancer HI > 1 and cancer risk > 1 in 10,000) for future commercial workers and future residents at multiple locations. These risks are due mainly to elevated concentrations of metals (arsenic, cadmium, manganese and other metals) in the dissolved and total fractions.

Concentrations of lead in filtered groundwater are lower than the federal action level of 15 ug/dL and are below a level concern to off-site residents or commercial workers if the groundwater was

ever consumed in the future. However, lead concentrations in unfiltered groundwater exceed the federal action level and would pose an unacceptable risk if it were used for drinking.

Estimated Future Risks to Human Receptors from Shallow Groundwater East of the Site

It is not believed that water from wells east of the site are currently used for drinking. If the water were used for drinking, non-cancer risks to off-site residents would be of potential concern due to a number of chemicals, especially cadmium. Cancer risks due to arsenic in filtered water would be within USEPA's target risk range (1E-04 to 1E-06) at most locations, with the exception of two locations. Estimated cancer risks from ingestion of unfiltered groundwater would be of concern at several additional locations. Risks from lead in filtered groundwater is not of concern to off-site residents, but at some locations lead in unfiltered groundwater could pose an unacceptable risk.

Estimated Risks to Ecological Receptors from Shallow Groundwater

In general, ecological receptors are not directly exposed to contaminants in groundwater. However, two exposure pathways could occur. First, contaminated groundwater could recharge the South Platte, leading to exposure of aquatic receptors in the river. However, screening level calculations of metal loading to, and the resulting incremental concentrations in, the South Platte River from the VBI70 OU3 site, suggest that under current conditions, the resulting incremental concentrations from site-related discharges to the South Platte River are likely to be small and below a level of significant concern.

Second, contaminated groundwater could be used to irrigate local gardens, causing potential phytotoxicity to garden vegetables. Screening level calculations suggest that irrigation over a long period of time (roughly 70 years) might cause phytotocxity to garden plants, but this conclusion should be considered to be uncertain due to the uncertainty in available plant phytotoxicity values for metals.

Conclusions Regarding Shallow Groundwater

Very little shallow groundwater is present below the site. However, concentration levels of site-related metals in the water that does exist beneath the site are sufficiently high that the water would not be safe for drinking. At present, because infiltration at the site is very limited, it is considered likely that off-site migration is likely to be minimal under current site conditions. This might change in the future, if changes in land use result in an increase in the pervious surface area at the site.

Historic releases of site-related metals appear to have impacted shallow groundwater in the Platte Valley alluvium east of the site, most clearly for cadmium and zinc. Concentrations of cadmium in off-site groundwater are elevated above background in an oval plume running to the northeast, parallel to the Platte River Valley terrace. Concentration values exceed Federal drinking water standard at some of these wells, indicating that the water would not be safe for drinking. However, the exact extent of cadmium values above the MCL are uncertain due to limitations in the available data.

8.0 REFERENCES

Bowers, T.S., Beck, B.D., Karam, H.S. 1994. Assessing the Relationship Between Environmental Lead Concentrations and Adult Blood Lead Levels. Risk Analysis 14:183-189.

CDC. 1991. Preventing lead poisoning in young children. A statement by the Centers of Disease Control (CDC) - October. U.S. Department of Health and Human Services. Public Health Service.

Colorado Department of Public Health and the Environment (CDPHE). 1992. Preliminary Assessment Argo Smelter Site. Denver County, Colorado. Prepared by Austin N. Buckingham. May 22.

Colorado Division of Water Resources (CDWR). 2007. Well Data. http://water.state.co.us/pubs/welldata.asp. (Accessed July 2007).

Dragun, James. 1988. The Soil Chemistry of Hazardous Materials. Hazardous Materials Control Research Institute. Silver Spring, Maryland.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Prepared for the U.S. Department of Energy, Office of Environmental Management by Lockheed Martin Energy Systems, Inc. managing the Oak Ridge National Laboratory (ORNL). ORNL publication. ES/ER/TM-85/R3, November 1997.

Fossett, Frank. 1973. Colorado, Its Gold and Silver Mines Farms and Stock Ranges and Health and Pleasure Resorts. A Tourist's Guide to the Rocky Mountains. Arno Press. New York, New York.

Goyer, R.A. 1990. Transplacental Transport of Lead. Environ. Health Perspect. 89:101-105.

Klodt, DT. 1952. The Argo Works of the Boston and Colorado Smelting Company. Colorado School of Mines. March 14.

Knight Piésold. 2005a. Memorandum to Victor Ketellapper: Argo Smelter Plume. August 2.

Knight Piesold. 2005b. Review of As Constructed Drawings in the Vicinity of I-25/I-70 to Assess the Influence of I-25 on Ground-Water Flow Towrad the South Platte River. February 24.

Knight Piésold. 2006. Vasquez Boulevard and Interstate 70 Operable Unit (OU3) Groundwater Samplign and Analysis Plan Amendment. Prepared for USEPA. August 15.

National Archives and Records Administration (NARS). 1937. Aerial Photograph. July 16.

Robson S.G. 1996. Geohydrology of the Shallow Aquifers in the Denver Metropolitan Area, Colorado. USGS Hydrologic Investigations. Atlas HA-736.

Robson S.G., Romero J.C. 1981. Geologic Structure, Hydrology and Water Quality of the Dawson Aquifer in the Denver, Basin, Colorado.

Shacklette and Boerngen. 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. U.S. Geological Survey Professional Paper 1270.

TRC Environmental Consultants, Inc. (TRC). 1988. Draft Remedial Investigation Report of the Globe Plant Site, Denver, Colorado. Joint study by ASARCO Incorporated and the State of Colorado. September 20.

USEPA. 1989. Risk Assessment Guidance for Superfund (RAGS). Volume I. Human Health Evaluation Manual (Part A).

USEPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." Washington, DC. OSWER Directive 9285.6-03.

USEPA. 1991b. Update on OSWER Soil Lead Cleanup Guidance. Memo from Don R. Clay, Assistant Administrator, dated August 29, 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

USEPA. 1991c. Update on OSWER Soil Lead Cleanup Guidance. Memo from Don R. Clay, Assistant Administrator, dated August 29, 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

USEPA. 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Draft.

USEPA. 1994. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Elliot P. Laws, Assistant Administrator. July 14, 1994. OSWER Directive 9355.4-12.

USEPA. 1996a. Soil Screening Guidance: Technical Background Document. OSWER. EPA/540/R95/128. May.

USEPA. 1996b. U.S. Environmental Protection Agency. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. December 1996.

USEPA 1997c. Health Effects Assessment Summary Tables. FY 1997 Update. EPA-540-R-97-036. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Washington, D.C. July.

USEPA. 2002. Blood lead concentrations of U.S. adult females: Summary statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). U.S. Environmental Protection Agency, Technical Review Workgroup for Lead.

USEPA. 2003a. Vasquez Boulevard and Interstate 70 (VBI70) Operable Unit 3 (OU3) Denver, Colorado. Quality Assurance Project Plan and Sampling and Analysis Plan to Support Human and Ecological Risk Assessment and Remedial Investigation. Prepared for USEPA by Knight Piésold and Syracuse Research Corporation. December.

USEPA. 2003b. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. January.

USEPA 2003c. Guidance for Deriving Ecological Soil Screening Levels (Eco-SSLs). Interim Final. December.

USEPA 2003d. Human Health Toxicity Values in Superfund Risk Assessments. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation. OSWER Directive 9285.7-53. December 5, 2003.

USEPA. 2004a. Field Sampling Report, Round I, Phase I for the Vasquez Boulevard and Interstate 70 (VBI70) Site, Operable Unit 3 (OU3), Denver, Colorado. Prepared for USEPA by Knight Piésold and Co. March.

USEPA. 2004b. Draft Technical Memorandum Phase I, Round II Groundwater Monitoring Vasquez Boulevard and Interstate 70 (VBI70), Operable Unit 3 (OU3) Denver Colorado. Prepared by Knight Piésold. September 13.

USEPA. 2004c. Memorandum. Phase I, Round II Groundwater Monitoring, Vasquez Boulevard and Interstate 70, Operable Unit 3 (OU3), Denver, CO. Prepared by Helen Dawson, Hydrogeologist, Superfund Program Support, for Victor Ketellapper, RPM. November 9.

USEPA. 2005a. Draft-Final Baseline Human Health and Screening Level Ecological Risk Assessment for the Vasquez Boulevard and Interstate 70 Site, Operable Unit 3, Denver,

Colorado. October 2004. Prepared by USEPA Region 8 with Technical Assistance from Knight Piésold and Syracuse Research Corporation.

USEPA. 2005b. USEPA Region III Risk-Based Concentration Table (last updated April 2005). Electronic data downloaded from http://www.epa.gov/reg3hwmd/risk/human/index.htm.

USEPA. 2005c. Vasquez Boulevard PES Evaluation Report. USEPA Region VIII. June.

USEPA. 2006. Final Baseline Human Health and Screening Level Ecological Risk Assessment for the Vasquez Boulevard and Interstate 70 Site, Operable Unit 3, Denver, Colorado. September. Prepared by USEPA Region 8 with Technical Assistance from Knight Piésold and Syracuse Research Corporation.

Western Regional Climate Center. 2004. Climate Data Summary for Denver, Colorado. http://www.wrcc.dri.edu/cgi-bin/clilcd.pl?co23062 Accessed April 2004.

TABLES

Table 3-1. Results for Soil Samples Collected at VBI70 OU3 During the Remedial Investigation of the ASARCO Globe Plant Site

Sample Location	Depth (cm)	Concentration (mg/kg)			
		Arsenic	Cadmium	Lead	Zinc
E5-6	0-5	14	2.6	225	238
	5-15	18	2.4	135	199
E5-7	0-5	17	7.3	675	600
	5-15	18	19	625	1060
E5-8	0-5	19	2.3	40	123
	5-15	14	1	35	81

Source: TRC, 1988

Table 3-2. Summary Statistics for Chemicals Measured in Soil

Chemical	Number of Detects	Total Number of Samples	Detection Frequency	Concentration [1] (mg/kg)		
				Minimum	Maximum	Average
Aluminum	123	123	100%	1400	45000	23000
Antimony	5	123	4%	0.5	85	1.3
Arsenic	111	123	90%	0.5	2900	30
Barium	123	123	100%	11	1800	280
Beryllium	81	123	66%	0.25	2.5	0.64
Cadmium	37	123	30%	0.25	510	8.2
Calcium	123	123	100%	600	80000	10000
Chromium	123	123	100%	2.2	71	14
Cobalt	122	123	99%	0.5	61	8.3
Copper	123	123	100%	2.8	3600	120
Iron	123	123	100%	3300	140000	22000
Lead	122	123	99%	0.4	1600	58
Magnesium	123	123	100%	330	9300	3900
Manganese	123	123	100%	30	3600	370
Mercury	30	123	24%	0.016	1.6	0.073
Nickel	118	123	96%	2	100	12
Potassium	121	123	98%	150	3800	1900
Selenium	3	123	2%	0.65	4	0.71
Silver	17	123	14%	0.5	29	1.2
Sodium	92	123	75%	250	10000	1300
Thallium	5	123	4%	0.6	12	0.75
Vanadium	123	123	100%	4.6	73	39
Zinc	123	123	100%	14	3500	160

[1] Nondetects adjusted to 1/2 detection limit

Table 3-3. Summary of Round 2 Groundwater Sampling Attempts

STATION	ROUND 2 GROUNDWATER MONITORING			
	April 5/3/2004	May 5/21/2004	June 7/1/2004	July 7/28/2004
MW-32	dry	sampled	sampled	sampled
MW-33	sampled	sampled	sampled	sampled
MW-34	dry	sampled	sampled	sampled
MW-35	dry	sampled*	dry	sampled
MW-36	dry	sampled*	sampled	sampled

**total metals sample collected from purge water on 5/21/2004; filtered water sample collected after purging on 5/24/2004*

Table 3-4. Summary Statistics for Chemicals Measured in Groundwater

Chemical	Analysis Type	Number of Detects	Total Number of Samples	Detection Frequency	Concentration [1] (ug/L)		
					Minimum	Maximum	Average
Aluminum	Dissolved	2	16	13%	50	110	54
	Total Recoverable	11	12	92%	50	360000	34000
Antimony	Dissolved	1	16	6%	1	2.5	1.1
	Total Recoverable	1	12	8%	1	40	4.3
Arsenic	Dissolved	15	16	94%	0.5	33	4.7
	Total Recoverable	10	12	83%	0.5	12000	1000
Barium	Dissolved	16	16	100%	23	110	56
	Total Recoverable	12	12	100%	29	1400	210
Beryllium	Dissolved	0	16	0%	0.5	0.5	0.5
	Total Recoverable	2	12	17%	0.5	26	2.8
Cadmium	Dissolved	14	16	88%	0.5	1800	130
	Total Recoverable	11	12	92%	0.5	7400	710
Calcium	Dissolved	16	16	100%	66000	630000	280000
	Total Recoverable	12	12	100%	66000	740000	320000
Chromium	Dissolved	0	16	0%	1	5	4.5
	Total Recoverable	2	12	17%	2	460	44
Cobalt	Dissolved	6	16	38%	5	36	10
	Total Recoverable	4	12	33%	5	200	29
Copper	Dissolved	6	16	38%	4	31	11
	Total Recoverable	6	12	50%	5	38000	3200
Iron	Dissolved	5	16	31%	50	26000	1900
	Total Recoverable	12	12	100%	160	1100000	100000
Lead	Dissolved	2	16	13%	1.4	2.3	1.5
	Total Recoverable	4	12	33%	1.5	16000	1300
Magnesium	Dissolved	16	16	100%	6600	61000	32000
	Total Recoverable	12	12	100%	6700	150000	42000
Manganese	Dissolved	14	16	88%	5	8200	1400
	Total Recoverable	12	12	100%	23	23000	2800
Mercury	Dissolved	0	15	0%	0.03	0.1	0.091
	Total Recoverable	1	12	8%	0.03	18	1.6
Nickel	Dissolved	2	16	13%	20	37	22
	Total Recoverable	3	12	25%	20	890	100
Potassium	Dissolved	10	16	63%	1500	14000	6000
	Total Recoverable	7	12	58%	1500	92000	13000
Selenium	Dissolved	2	16	13%	7.1	11	7.7
	Total Recoverable	2	12	17%	7.5	39	10
Silver	Dissolved	0	16	0%	0.2	5	4.4
	Total Recoverable	2	12	17%	2.2	220	23
Sodium	Dissolved	16	16	100%	88000	880000	400000
	Total Recoverable	12	12	100%	82000	900000	460000
Thallium	Dissolved	2	16	13%	0.5	2	0.6
	Total Recoverable	2	12	17%	0.5	300	26
Vanadium	Dissolved	2	16	13%	5	12	5.9
	Total Recoverable	3	12	25%	5	540	56
Zinc	Dissolved	11	16	69%	10	10000	800
	Total Recoverable	9	12	75%	10	85000	8200

[1] Nondetects adjusted to 1/2 detection limit

Table 3-5. Water Level Measurements of Shallow Groundwater at the VBI70 OU3 Site

Station	Depth to Groundwater (ft bgs)				
	Dec-04	Apr-04	May-04	Jun-04	Jul-04
04	11.0	--	--	--	--
07	12.2	--	--	--	--
32	--	dry	dry	6.1	3.9
33	--	16.1	15.6	15.6	15.7
34	--	dry	21.1	20	19.8
35	--	dry	11.2	dry	11.2
36	--	dry	8.3	8.4	8.5

ft bgs = feet below ground surface

dry = Well surveyed and groundwater not present

-- = Well not surveyed

Table 3-6. Summary Statistics for Chemicals Measured in Groundwater (Off-Site)

Chemical	Analysis Type	Number of Detects	Total Number of Samples	Detection Frequency	Concentration [1] (ug/L)		
					Minimum	Maximum	Average
Aluminum	Dissolved	7	21	33%	50	500	110
	Total Recoverable	19	21	90%	50	360000	49000
Antimony	Dissolved	0	21	0%	1	1	1
	Total Recoverable	0	15 [2]	0%	1	1	1
Arsenic	Dissolved	11	110	10%	0.5	25	2.8
	Total Recoverable	24	31	77%	0.5	90	17
Barium	Dissolved	21	21	100%	16	210	120
	Total Recoverable	21	21	100%	74	3200	650
Beryllium	Dissolved	0	21	0%	0.5	0.5	0.5
	Total Recoverable	12	21	57%	0.5	29	3.7
Cadmium	Dissolved	97	110	88%	0.5	120	39
	Total Recoverable	31	33	94%	0.5	320	54
Calcium	Dissolved	21	21	100%	65000	640000	180000
	Total Recoverable	21	21	100%	100000	630000	190000
Chromium	Dissolved	0	21	0%	5	5	5
	Total Recoverable	15	21	71%	5	930	100
Cobalt	Dissolved	3	21	14%	5	23	6.9
	Total Recoverable	13	21	62%	5	180	29
Copper	Dissolved	0	21	0%	5	5	5
	Total Recoverable	16	21	76%	5	710	92
Iron	Dissolved	16	21	76%	50	1000	280
	Total Recoverable	20	21	95%	50	810000	85000
Lead	Dissolved	6	90	7%	1.5	27	3.1
	Total Recoverable	26	31	84%	1.5	630	64
Magnesium	Dissolved	21	21	100%	12000	83000	33000
	Total Recoverable	21	21	100%	14000	120000	41000
Manganese	Dissolved	20	21	95%	5	3700	860
	Total Recoverable	21	21	100%	11	18000	3600
Mercury	Dissolved	0	21	0%	0.1	0.1	0.1
	Total Recoverable	3	21	14%	0.1	1.3	0.17
Nickel	Dissolved	0	21	0%	20	20	20
	Total Recoverable	10	21	48%	20	330	53
Potassium	Dissolved	20	21	95%	1500	32000	17000
	Total Recoverable	21	21	100%	3200	63000	25000
Selenium	Dissolved	0	21	0%	7.5	7.5	7.5
	Total Recoverable	2	21	10%	7.5	43	10
Silver	Dissolved	0	21	0%	5	5	5
	Total Recoverable	0	21	0%	5	5	5
Sodium	Dissolved	21	21	100%	150000	660000	260000
	Total Recoverable	21	21	100%	160000	610000	240000
Thallium	Dissolved	0	21	0%	0.5	0.5	0.5
	Total Recoverable	5	21	24%	0.5	3.5	0.81
Vanadium	Dissolved	0	21	0%	5	5	5
	Total Recoverable	18	21	86%	5	1000	120
Zinc	Dissolved	101	110	92%	4	360	120
	Total Recoverable	33	33	100%	37	4800	530

[1] Nondetects adjusted to 1/2 detection limit

[2] Of the 10 results for antimony, 6 were "R" qualified (rejected) during validation and excluded from the data set used for the remedial investigation.

Table 3-7. Summary Statistics for Chemicals Measured in Surface Water (Storm Drain Outfall)

Chemical	Analysis Type	Number of Detects	Total Number of Samples	Detection Frequency	Concentration [1] (ug/L)		
					Minimum	Maximum	Average
Aluminum	Total Recoverable	1	2	50%	50	230	140
Antimony	Total Recoverable	0	2	0%	1	1	1
Arsenic	Total Recoverable	1	2	50%	0.5	1	0.75
Barium	Total Recoverable	2	2	100%	33	34	34
Beryllium	Total Recoverable	0	2	0%	0.5	0.5	0.5
Cadmium	Total Recoverable	2	2	100%	4.6	5.3	5
Calcium	Total Recoverable	2	2	100%	66000	70000	68000
Chromium	Total Recoverable	0	2	0%	5	5	5
Cobalt	Total Recoverable	0	2	0%	5	5	5
Copper	Total Recoverable	0	2	0%	5	5	5
Iron	Total Recoverable	2	2	100%	150	240	200
Lead	Total Recoverable	0	2	0%	1.5	1.5	1.5
Magnesium	Total Recoverable	2	2	100%	12000	12000	12000
Manganese	Total Recoverable	0	2	0%	5	5	5
Mercury	Total Recoverable	0	2	0%	0.1	0.1	0.1
Nickel	Total Recoverable	0	2	0%	20	20	20
Potassium	Total Recoverable	0	2	0%	1500	1500	1500
Selenium	Total Recoverable	0	2	0%	7.5	7.5	7.5
Silver	Total Recoverable	0	2	0%	5	5	5
Sodium	Total Recoverable	2	2	100%	150000	170000	160000
Thallium	Total Recoverable	0	2	0%	0.5	0.5	0.5
Vanadium	Total Recoverable	0	2	0%	5	5	5
Zinc	Total Recoverable	2	2	100%	22	25	24

[1] Nondetects adjusted to 1/2 detection limit

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0001-A	D3L190461001	Soil	Field QC	PE Std	Total	Antimony	3.2	mg/kg		J
01-VBOU3-SB-0001-A	D3L190461001	Soil	Field QC	PE Std	Total	Manganese	760	mg/kg		J
01-VBOU3-SB-0001-A	D3L190461001	Soil	Field QC	PE Std	Total	Vanadium	250	mg/kg		J
01-VBOU3-SB-0001-B	D3L190461002	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0001-B	D3L190461002	Soil	Field		Total	Manganese	250	mg/kg		J
01-VBOU3-SB-0001-B	D3L190461002	Soil	Field		Total	Vanadium	44	mg/kg		J
01-VBOU3-SB-0001-C	D3L190461003	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0001-C	D3L190461003	Soil	Field		Total	Manganese	570	mg/kg		J
01-VBOU3-SB-0001-C	D3L190461003	Soil	Field		Total	Vanadium	46	mg/kg		J
01-VBOU3-SB-0001-D	D3L190461004	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0001-D	D3L190461004	Soil	Field		Total	Manganese	230	mg/kg		J
01-VBOU3-SB-0001-D	D3L190461004	Soil	Field		Total	Vanadium	33	mg/kg		J
01-VBOU3-SB-0002-A	D3L190405005	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0002-A	D3L190405005	Soil	Field		Total	Chromium	9.4	mg/kg		J
01-VBOU3-SB-0002-A	D3L190405005	Soil	Field		Total	Copper	3.8	mg/kg		J
01-VBOU3-SB-0002-B	D3L190405006	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0002-B	D3L190405006	Soil	Field		Total	Chromium	11	mg/kg		J
01-VBOU3-SB-0002-B	D3L190405006	Soil	Field		Total	Copper	5	mg/kg		J
01-VBOU3-SB-0002-C	D3L190405007	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0002-C	D3L190405007	Soil	Field		Total	Chromium	15	mg/kg		J
01-VBOU3-SB-0002-C	D3L190405007	Soil	Field		Total	Copper	8.7	mg/kg		J
01-VBOU3-SB-0002-D	D3L190419009	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0002-D	D3L190419009	Soil	Field		Total	Barium	340	mg/kg		J
01-VBOU3-SB-0002-D	D3L190419009	Soil	Field		Total	Lead	7.1	mg/kg		J
01-VBOU3-SB-0002-D	D3L190419009	Soil	Field		Total	Manganese	350	mg/kg		J
01-VBOU3-SB-0002-E	D3L190405008	Soil	Field QC	PE Std	Total	Antimony	2.9	mg/kg		J
01-VBOU3-SB-0002-E	D3L190405008	Soil	Field QC	PE Std	Total	Chromium	7.1	mg/kg		J
01-VBOU3-SB-0002-E	D3L190405008	Soil	Field QC	PE Std	Total	Copper	1300	mg/kg		J
01-VBOU3-SB-0003-A	D3L190419005	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0003-A	D3L190419005	Soil	Field		Total	Barium	320	mg/kg		J
01-VBOU3-SB-0003-A	D3L190419005	Soil	Field		Total	Lead	270	mg/kg		J
01-VBOU3-SB-0003-A	D3L190419005	Soil	Field		Total	Manganese	550	mg/kg		J
01-VBOU3-SB-0003-A	D3L190419005	Soil	Field		Total	Silver	13	mg/kg		J
01-VBOU3-SB-0003-B	D3L190419006	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0003-B	D3L190419006	Soil	Field		Total	Barium	500	mg/kg		J
01-VBOU3-SB-0003-B	D3L190419006	Soil	Field		Total	Lead	11	mg/kg		J
01-VBOU3-SB-0003-B	D3L190419006	Soil	Field		Total	Manganese	290	mg/kg		J
01-VBOU3-SB-0003-C	D3L190419007	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0003-C	D3L190419007	Soil	Field		Total	Barium	580	mg/kg		J
01-VBOU3-SB-0003-C	D3L190419007	Soil	Field		Total	Lead	10	mg/kg		J
01-VBOU3-SB-0003-C	D3L190419007	Soil	Field		Total	Manganese	310	mg/kg		J
01-VBOU3-SB-0003-D	D3L190419008	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0003-D	D3L190419008	Soil	Field		Total	Barium	330	mg/kg		J
01-VBOU3-SB-0003-D	D3L190419008	Soil	Field		Total	Lead	13	mg/kg		J
01-VBOU3-SB-0003-D	D3L190419008	Soil	Field		Total	Manganese	440	mg/kg		J
01-VBOU3-SB-0004-A	D3L190419001	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0004-A	D3L190419001	Soil	Field		Total	Barium	160	mg/kg		J
01-VBOU3-SB-0004-A	D3L190419001	Soil	Field		Total	Cadmium	3.2	mg/kg		J
01-VBOU3-SB-0004-A	D3L190419001	Soil	Field		Total	Lead	190	mg/kg		J
01-VBOU3-SB-0004-A	D3L190419001	Soil	Field		Total	Manganese	180	mg/kg		J
01-VBOU3-SB-0004-A	D3L190419001	Soil	Field		Total	Silver	2.1	mg/kg		J
01-VBOU3-SB-0004-B	D3L190419002	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0004-B	D3L190419002	Soil	Field		Total	Barium	74	mg/kg		J
01-VBOU3-SB-0004-B	D3L190419002	Soil	Field		Total	Lead	11	mg/kg		J
01-VBOU3-SB-0004-B	D3L190419002	Soil	Field		Total	Manganese	210	mg/kg		J
01-VBOU3-SB-0004-C	D3L190419003	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0004-C	D3L190419003	Soil	Field		Total	Barium	410	mg/kg		J
01-VBOU3-SB-0004-C	D3L190419003	Soil	Field		Total	Cadmium	150	mg/kg		J
01-VBOU3-SB-0004-C	D3L190419003	Soil	Field		Total	Lead	9.4	mg/kg		J
01-VBOU3-SB-0004-C	D3L190419003	Soil	Field		Total	Manganese	150	mg/kg		J
01-VBOU3-SB-0004-D	D3L190419004	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0004-D	D3L190419004	Soil	Field		Total	Barium	570	mg/kg		J
01-VBOU3-SB-0004-D	D3L190419004	Soil	Field		Total	Cadmium	7.3	mg/kg		J
01-VBOU3-SB-0004-D	D3L190419004	Soil	Field		Total	Lead	8.5	mg/kg		J
01-VBOU3-SB-0004-D	D3L190419004	Soil	Field		Total	Manganese	360	mg/kg		J

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0005-A	D3L190419011	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0005-A	D3L190419011	Soil	Field		Total	Barium	280	mg/kg		J
01-VBOU3-SB-0005-A	D3L190419011	Soil	Field		Total	Cadmium	0.73	mg/kg		J
01-VBOU3-SB-0005-A	D3L190419011	Soil	Field		Total	Lead	160	mg/kg		J
01-VBOU3-SB-0005-A	D3L190419011	Soil	Field		Total	Manganese	230	mg/kg		J
01-VBOU3-SB-0005-A	D3L190419011	Soil	Field		Total	Silver	12	mg/kg		J
01-VBOU3-SB-0005-B	D3L190419012	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0005-B	D3L190419012	Soil	Field		Total	Barium	720	mg/kg		J
01-VBOU3-SB-0005-B	D3L190419012	Soil	Field		Total	Lead	6.4	mg/kg		J
01-VBOU3-SB-0005-B	D3L190419012	Soil	Field		Total	Manganese	170	mg/kg		J
01-VBOU3-SB-0005-C	D3L190419013	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0005-C	D3L190419013	Soil	Field		Total	Barium	360	mg/kg		J
01-VBOU3-SB-0005-C	D3L190419013	Soil	Field		Total	Lead	11	mg/kg		J
01-VBOU3-SB-0005-C	D3L190419013	Soil	Field		Total	Manganese	210	mg/kg		J
01-VBOU3-SB-0005-D	D3L190419014	Soil	Field QC	PE Std	Total	Antimony	2.9	mg/kg		J
01-VBOU3-SB-0005-D	D3L190419014	Soil	Field QC	PE Std	Total	Barium	350	mg/kg		J
01-VBOU3-SB-0005-D	D3L190419014	Soil	Field QC	PE Std	Total	Cadmium	1.9	mg/kg		J
01-VBOU3-SB-0005-D	D3L190419014	Soil	Field QC	PE Std	Total	Lead	1300	mg/kg		J
01-VBOU3-SB-0005-D	D3L190419014	Soil	Field QC	PE Std	Total	Manganese	730	mg/kg		J
01-VBOU3-SB-0006-A	D3L190405009	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0006-A	D3L190405009	Soil	Field		Total	Chromium	23	mg/kg		J
01-VBOU3-SB-0006-A	D3L190405009	Soil	Field		Total	Copper	49	mg/kg		J
01-VBOU3-SB-0006-B	D3L190405010	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0006-B	D3L190405010	Soil	Field		Total	Chromium	16	mg/kg		J
01-VBOU3-SB-0006-B	D3L190405010	Soil	Field		Total	Copper	620	mg/kg		J
01-VBOU3-SB-0006-C	D3L190405011	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0006-C	D3L190405011	Soil	Field		Total	Chromium	14	mg/kg		J
01-VBOU3-SB-0006-C	D3L190405011	Soil	Field		Total	Copper	67	mg/kg		J
01-VBOU3-SB-0006-D	D3L190405012	Soil	Field QC	Duplicate	Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0006-D	D3L190405012	Soil	Field QC	Duplicate	Total	Chromium	16	mg/kg		J
01-VBOU3-SB-0006-D	D3L190405012	Soil	Field QC	Duplicate	Total	Copper	29	mg/kg		J
01-VBOU3-SB-0007-A	D3L190405013	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0007-A	D3L190405013	Soil	Field		Total	Chromium	11	mg/kg		J
01-VBOU3-SB-0007-A	D3L190405013	Soil	Field		Total	Copper	10	mg/kg		J
01-VBOU3-SB-0007-B	D3L190405014	Soil	Field		Total	Antimony	3.6	mg/kg		J
01-VBOU3-SB-0007-B	D3L190405014	Soil	Field		Total	Chromium	71	mg/kg		J
01-VBOU3-SB-0007-B	D3L190405014	Soil	Field		Total	Copper	330	mg/kg		J
01-VBOU3-SB-0007-C	D3L190405015	Soil	Field		Total	Antimony	85	mg/kg		J
01-VBOU3-SB-0007-C	D3L190405015	Soil	Field		Total	Chromium	9.8	mg/kg		J
01-VBOU3-SB-0007-C	D3L190405015	Soil	Field		Total	Copper	3100	mg/kg		J
01-VBOU3-SB-0007-D	D3L190405016	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0007-D	D3L190405016	Soil	Field		Total	Chromium	11	mg/kg		J
01-VBOU3-SB-0007-D	D3L190405016	Soil	Field		Total	Copper	83	mg/kg		J
01-VBOU3-SB-0007-E	D3L190405017	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0007-E	D3L190405017	Soil	Field		Total	Chromium	22	mg/kg		J
01-VBOU3-SB-0007-E	D3L190405017	Soil	Field		Total	Copper	23	mg/kg		J
01-VBOU3-SB-0008-A	D3L190405001	Soil	Field		Total	Antimony	2.1	mg/kg		J
01-VBOU3-SB-0008-A	D3L190405001	Soil	Field		Total	Chromium	20	mg/kg		J
01-VBOU3-SB-0008-A	D3L190405001	Soil	Field		Total	Copper	280	mg/kg		J
01-VBOU3-SB-0008-B	D3L190405002	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0008-B	D3L190405002	Soil	Field		Total	Chromium	10	mg/kg		J
01-VBOU3-SB-0008-B	D3L190405002	Soil	Field		Total	Copper	190	mg/kg		J
01-VBOU3-SB-0008-C	D3L190405003	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0008-C	D3L190405003	Soil	Field		Total	Chromium	15	mg/kg		J
01-VBOU3-SB-0008-C	D3L190405003	Soil	Field		Total	Copper	18	mg/kg		J
01-VBOU3-SB-0008-D	D3L190405004	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0008-D	D3L190405004	Soil	Field		Total	Chromium	17	mg/kg		J
01-VBOU3-SB-0008-D	D3L190405004	Soil	Field		Total	Copper	16	mg/kg		J
01-VBOU3-SB-0009-A	D3L190390017	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0009-A	D3L190390017	Soil	Field		Total	Lead	100	mg/kg		J
01-VBOU3-SB-0009-A	D3L190390017	Soil	Field		Total	Manganese	240	mg/kg	L	J
01-VBOU3-SB-0009-A	D3L190390017	Soil	Field		Total	Zinc	120	mg/kg		J
01-VBOU3-SB-0009-B	D3L190390018	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0009-B	D3L190390018	Soil	Field		Total	Lead	11	mg/kg		J

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0009-B	D3L190390018	Soil	Field		Total	Manganese	250	mg/kg	L	J
01-VBOU3-SB-0009-B	D3L190390018	Soil	Field		Total	Zinc	56	mg/kg		J
01-VBOU3-SB-0009-C	D3L190390019	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0009-C	D3L190390019	Soil	Field		Total	Lead	18	mg/kg		J
01-VBOU3-SB-0009-C	D3L190390019	Soil	Field		Total	Manganese	500	mg/kg	L	J
01-VBOU3-SB-0009-C	D3L190390019	Soil	Field		Total	Zinc	51	mg/kg		J
01-VBOU3-SB-0009-D	D3L190390020	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0009-D	D3L190390020	Soil	Field		Total	Lead	17	mg/kg		J
01-VBOU3-SB-0009-D	D3L190390020	Soil	Field		Total	Manganese	190	mg/kg	L	J
01-VBOU3-SB-0009-D	D3L190390020	Soil	Field		Total	Zinc	110	mg/kg		J
01-VBOU3-SB-0010-A	D3L100414011	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0010-A	D3L100414011	Soil	Field		Total	Barium	660	mg/kg	L	J
01-VBOU3-SB-0010-A	D3L100414011	Soil	Field		Total	Zinc	1200	mg/kg		J
01-VBOU3-SB-0010-B	D3L100414012	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0010-B	D3L100414012	Soil	Field		Total	Barium	30	mg/kg	L	J
01-VBOU3-SB-0010-B	D3L100414012	Soil	Field		Total	Zinc	48	mg/kg		J
01-VBOU3-SB-0010-C	D3L100414013	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0010-C	D3L100414013	Soil	Field		Total	Barium	41	mg/kg	L	J
01-VBOU3-SB-0010-C	D3L100414013	Soil	Field		Total	Zinc	58	mg/kg		J
01-VBOU3-SB-0010-D	D3L100414014	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0010-D	D3L100414014	Soil	Field		Total	Barium	63	mg/kg	L	J
01-VBOU3-SB-0010-D	D3L100414014	Soil	Field		Total	Mercury	ND	mg/kg		UJ
01-VBOU3-SB-0010-D	D3L100414014	Soil	Field		Total	Zinc	58	mg/kg		J
01-VBOU3-SB-0012-A	D3L190461011	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0012-A	D3L190461011	Soil	Field		Total	Manganese	420	mg/kg		J
01-VBOU3-SB-0012-A	D3L190461011	Soil	Field		Total	Vanadium	34	mg/kg		J
01-VBOU3-SB-0012-B	D3L190461012	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0012-B	D3L190461012	Soil	Field		Total	Manganese	350	mg/kg		J
01-VBOU3-SB-0012-B	D3L190461012	Soil	Field		Total	Vanadium	36	mg/kg		J
01-VBOU3-SB-0013-A	D3L190461013	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0013-A	D3L190461013	Soil	Field		Total	Manganese	340	mg/kg		J
01-VBOU3-SB-0013-A	D3L190461013	Soil	Field		Total	Vanadium	34	mg/kg		J
01-VBOU3-SB-0013-B	D3L190461014	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0013-B	D3L190461014	Soil	Field		Total	Manganese	350	mg/kg		J
01-VBOU3-SB-0013-B	D3L190461014	Soil	Field		Total	Vanadium	37	mg/kg		J
01-VBOU3-SB-0014-A	D3L110408003	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0014-A	D3L110408003	Soil	Field		Total	Lead	13	mg/kg		J
01-VBOU3-SB-0014-A	D3L110408003	Soil	Field		Total	Manganese	400	mg/kg		J
01-VBOU3-SB-0014-B	D3L110408004	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0014-B	D3L110408004	Soil	Field		Total	Lead	11	mg/kg		J
01-VBOU3-SB-0014-B	D3L110408004	Soil	Field		Total	Manganese	560	mg/kg		J
01-VBOU3-SB-0014-C	D3L110408005	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0014-C	D3L110408005	Soil	Field		Total	Lead	12	mg/kg		J
01-VBOU3-SB-0014-C	D3L110408005	Soil	Field		Total	Manganese	640	mg/kg		J
01-VBOU3-SB-0015-A	D3L190405018	Soil	Field		Total	Antimony	10	mg/kg		J
01-VBOU3-SB-0015-A	D3L190405018	Soil	Field		Total	Chromium	18	mg/kg		J
01-VBOU3-SB-0015-A	D3L190405018	Soil	Field		Total	Copper	210	mg/kg		J
01-VBOU3-SB-0015-B	D3L190405019	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0015-B	D3L190405019	Soil	Field		Total	Chromium	13	mg/kg		J
01-VBOU3-SB-0015-B	D3L190405019	Soil	Field		Total	Copper	140	mg/kg		J
01-VBOU3-SB-0015-C	D3L190405020	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0015-C	D3L190405020	Soil	Field		Total	Chromium	20	mg/kg		J
01-VBOU3-SB-0015-C	D3L190405020	Soil	Field		Total	Copper	19	mg/kg		J
01-VBOU3-SB-0016-A	D3L100414017	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0016-A	D3L100414017	Soil	Field		Total	Barium	23	mg/kg	L	J
01-VBOU3-SB-0016-A	D3L100414017	Soil	Field		Total	Mercury	ND	mg/kg		UJ
01-VBOU3-SB-0016-A	D3L100414017	Soil	Field		Total	Zinc	37	mg/kg		J
01-VBOU3-SB-0016-B	D3L100414018	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0016-B	D3L100414018	Soil	Field		Total	Barium	1500	mg/kg	L	J
01-VBOU3-SB-0016-B	D3L100414018	Soil	Field		Total	Beryllium	ND	mg/kg		UJ
01-VBOU3-SB-0016-B	D3L100414018	Soil	Field		Total	Mercury	ND	mg/kg		UJ
01-VBOU3-SB-0016-B	D3L100414018	Soil	Field		Total	Zinc	54	mg/kg		J
01-VBOU3-SB-0016-C	D3L100414019	Soil	Field QC	Duplicate	Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0016-C	D3L100414019	Soil	Field QC	Duplicate	Total	Barium	1400	mg/kg	L	J

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0016-C	D3L100414019	Soil	Field QC	Duplicate	Total	Mercury	ND	mg/kg		UJ
01-VBOU3-SB-0016-C	D3L100414019	Soil	Field QC	Duplicate	Total	Zinc	46	mg/kg		J
01-VBOU3-SB-0016-D	D3L100414020	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0016-D	D3L100414020	Soil	Field		Total	Barium	54	mg/kg	L	J
01-VBOU3-SB-0016-D	D3L100414020	Soil	Field		Total	Mercury	0.033	mg/kg		J
01-VBOU3-SB-0016-D	D3L100414020	Soil	Field		Total	Zinc	66	mg/kg		J
01-VBOU3-SB-0017-A	D3L110408009	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0017-A	D3L110408009	Soil	Field		Total	Lead	43	mg/kg		J
01-VBOU3-SB-0017-A	D3L110408009	Soil	Field		Total	Manganese	120	mg/kg		J
01-VBOU3-SB-0017-B	D3L110408010	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0017-B	D3L110408010	Soil	Field		Total	Lead	7.2	mg/kg		J
01-VBOU3-SB-0017-B	D3L110408010	Soil	Field		Total	Manganese	850	mg/kg		J
01-VBOU3-SB-0017-C	D3L110408011	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0017-C	D3L110408011	Soil	Field		Total	Lead	16	mg/kg		J
01-VBOU3-SB-0017-C	D3L110408011	Soil	Field		Total	Manganese	530	mg/kg		J
01-VBOU3-SB-0017-D	D3L110408012	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0017-D	D3L110408012	Soil	Field		Total	Lead	3.4	mg/kg		J
01-VBOU3-SB-0017-D	D3L110408012	Soil	Field		Total	Manganese	86	mg/kg		J
01-VBOU3-SB-0018-A	D3L110408016	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0018-A	D3L110408016	Soil	Field		Total	Lead	44	mg/kg		J
01-VBOU3-SB-0018-A	D3L110408016	Soil	Field		Total	Manganese	170	mg/kg		J
01-VBOU3-SB-0018-B	D3L110408017	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0018-B	D3L110408017	Soil	Field		Total	Lead	12	mg/kg		J
01-VBOU3-SB-0018-B	D3L110408017	Soil	Field		Total	Manganese	1900	mg/kg		J
01-VBOU3-SB-0018-C	D3L110408018	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0018-C	D3L110408018	Soil	Field		Total	Lead	7.8	mg/kg		J
01-VBOU3-SB-0018-C	D3L110408018	Soil	Field		Total	Manganese	1000	mg/kg		J
01-VBOU3-SB-0018-D	D3L110408019	Soil	Field QC	Duplicate	Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0018-D	D3L110408019	Soil	Field QC	Duplicate	Total	Lead	7.5	mg/kg		J
01-VBOU3-SB-0018-D	D3L110408019	Soil	Field QC	Duplicate	Total	Manganese	1000	mg/kg		J
01-VBOU3-SB-0019-A	D3L100414015	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0019-A	D3L100414015	Soil	Field		Total	Barium	44	mg/kg	L	J
01-VBOU3-SB-0019-A	D3L100414015	Soil	Field		Total	Mercury	0.033	mg/kg		J
01-VBOU3-SB-0019-A	D3L100414015	Soil	Field		Total	Zinc	45	mg/kg		J
01-VBOU3-SB-0019-B	D3L100414016	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0019-B	D3L100414016	Soil	Field		Total	Barium	42	mg/kg	L	J
01-VBOU3-SB-0019-B	D3L100414016	Soil	Field		Total	Mercury	ND	mg/kg		UJ
01-VBOU3-SB-0019-B	D3L100414016	Soil	Field		Total	Zinc	50	mg/kg		J
01-VBOU3-SB-0020-A	D3L110408001	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0020-A	D3L110408001	Soil	Field		Total	Lead	7.3	mg/kg		J
01-VBOU3-SB-0020-A	D3L110408001	Soil	Field		Total	Manganese	890	mg/kg		J
01-VBOU3-SB-0020-B	D3L110408002	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0020-B	D3L110408002	Soil	Field		Total	Lead	18	mg/kg		J
01-VBOU3-SB-0020-B	D3L110408002	Soil	Field		Total	Manganese	1100	mg/kg		J
01-VBOU3-SB-0021-A	D3L110408013	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0021-A	D3L110408013	Soil	Field		Total	Lead	210	mg/kg		J
01-VBOU3-SB-0021-A	D3L110408013	Soil	Field		Total	Manganese	340	mg/kg		J
01-VBOU3-SB-0021-B	D3L110408014	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0021-B	D3L110408014	Soil	Field		Total	Lead	15	mg/kg		J
01-VBOU3-SB-0021-B	D3L110408014	Soil	Field		Total	Manganese	140	mg/kg		J
01-VBOU3-SB-0021-C	D3L110408015	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0021-C	D3L110408015	Soil	Field		Total	Lead	13	mg/kg		J
01-VBOU3-SB-0021-C	D3L110408015	Soil	Field		Total	Manganese	190	mg/kg		J
01-VBOU3-SB-0022-A	D3L190390013	Soil	Field		Total	Antimony	2	mg/kg		J
01-VBOU3-SB-0022-A	D3L190390013	Soil	Field		Total	Lead	380	mg/kg		J
01-VBOU3-SB-0022-A	D3L190390013	Soil	Field		Total	Manganese	280	mg/kg	L	J
01-VBOU3-SB-0022-A	D3L190390013	Soil	Field		Total	Zinc	410	mg/kg		J
01-VBOU3-SB-0022-B	D3L190390014	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0022-B	D3L190390014	Soil	Field		Total	Lead	140	mg/kg		J
01-VBOU3-SB-0022-B	D3L190390014	Soil	Field		Total	Manganese	570	mg/kg	L	J
01-VBOU3-SB-0022-B	D3L190390014	Soil	Field		Total	Zinc	110	mg/kg		J
01-VBOU3-SB-0022-C	D3L190390015	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0022-C	D3L190390015	Soil	Field		Total	Lead	15	mg/kg		J
01-VBOU3-SB-0022-C	D3L190390015	Soil	Field		Total	Manganese	380	mg/kg	L	J

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0022-C	D3L190390015	Soil	Field		Total	Zinc	72	mg/kg		J
01-VBOU3-SB-0022-D	D3L190419010	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0022-D	D3L190419010	Soil	Field		Total	Barium	38	mg/kg		J
01-VBOU3-SB-0022-D	D3L190419010	Soil	Field		Total	Lead	16	mg/kg		J
01-VBOU3-SB-0022-D	D3L190419010	Soil	Field		Total	Manganese	110	mg/kg		J
01-VBOU3-SB-0022-E	D3L190390016	Soil	Field QC	PE Std	Total	Antimony	3.3	mg/kg		J
01-VBOU3-SB-0022-E	D3L190390016	Soil	Field QC	PE Std	Total	Lead	1400	mg/kg		J
01-VBOU3-SB-0022-E	D3L190390016	Soil	Field QC	PE Std	Total	Manganese	770	mg/kg	L	J
01-VBOU3-SB-0022-E	D3L190390016	Soil	Field QC	PE Std	Total	Zinc	1700	mg/kg		J
01-VBOU3-SB-0023-A	D3L190464018	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0023-A	D3L190464018	Soil	Field		Total	Chromium	13	mg/kg		J
01-VBOU3-SB-0023-A	D3L190464018	Soil	Field		Total	Sodium	520	mg/kg		J
01-VBOU3-SB-0023-A	D3L190464018	Soil	Field		Total	Vanadium	30	mg/kg		J
01-VBOU3-SB-0023-A	D3L190464018	Soil	Field		Total	Zinc	93	mg/kg		J
01-VBOU3-SB-0023-B	D3L190464019	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0023-B	D3L190464019	Soil	Field		Total	Chromium	19	mg/kg		J
01-VBOU3-SB-0023-B	D3L190464019	Soil	Field		Total	Sodium	1300	mg/kg		J
01-VBOU3-SB-0023-B	D3L190464019	Soil	Field		Total	Vanadium	45	mg/kg		J
01-VBOU3-SB-0023-B	D3L190464019	Soil	Field		Total	Zinc	71	mg/kg		J
01-VBOU3-SB-0023-C	D3L190464020	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0023-C	D3L190464020	Soil	Field		Total	Chromium	13	mg/kg		J
01-VBOU3-SB-0023-C	D3L190464020	Soil	Field		Total	Sodium	1100	mg/kg		J
01-VBOU3-SB-0023-C	D3L190464020	Soil	Field		Total	Vanadium	34	mg/kg		J
01-VBOU3-SB-0023-C	D3L190464020	Soil	Field		Total	Zinc	67	mg/kg		J
01-VBOU3-SB-0024-A	D3L190464012	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0024-A	D3L190464012	Soil	Field		Total	Chromium	8.7	mg/kg		J
01-VBOU3-SB-0024-A	D3L190464012	Soil	Field		Total	Sodium	2200	mg/kg		J
01-VBOU3-SB-0024-A	D3L190464012	Soil	Field		Total	Vanadium	55	mg/kg		J
01-VBOU3-SB-0024-A	D3L190464012	Soil	Field		Total	Zinc	80	mg/kg		J
01-VBOU3-SB-0024-B	D3L190464013	Soil	Field QC	Duplicate	Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0024-B	D3L190464013	Soil	Field QC	Duplicate	Total	Chromium	7.7	mg/kg		J
01-VBOU3-SB-0024-B	D3L190464013	Soil	Field QC	Duplicate	Total	Sodium	1900	mg/kg		J
01-VBOU3-SB-0024-B	D3L190464013	Soil	Field QC	Duplicate	Total	Vanadium	52	mg/kg		J
01-VBOU3-SB-0024-B	D3L190464013	Soil	Field QC	Duplicate	Total	Zinc	65	mg/kg		J
01-VBOU3-SB-0024-C	D3L190464014	Soil	Field QC	PE Std	Total	Antimony	2.7	mg/kg		J
01-VBOU3-SB-0024-C	D3L190464014	Soil	Field QC	PE Std	Total	Chromium	7.6	mg/kg		J
01-VBOU3-SB-0024-C	D3L190464014	Soil	Field QC	PE Std	Total	Vanadium	260	mg/kg		J
01-VBOU3-SB-0024-C	D3L190464014	Soil	Field QC	PE Std	Total	Zinc	1900	mg/kg		J
01-VBOU3-SB-0024-D	D3L190464015	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0024-D	D3L190464015	Soil	Field		Total	Chromium	8	mg/kg		J
01-VBOU3-SB-0024-D	D3L190464015	Soil	Field		Total	Sodium	5100	mg/kg		J
01-VBOU3-SB-0024-D	D3L190464015	Soil	Field		Total	Vanadium	61	mg/kg		J
01-VBOU3-SB-0024-D	D3L190464015	Soil	Field		Total	Zinc	73	mg/kg		J
01-VBOU3-SB-0025-A	D3L190464016	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0025-A	D3L190464016	Soil	Field		Total	Chromium	5.9	mg/kg		J
01-VBOU3-SB-0025-A	D3L190464016	Soil	Field		Total	Sodium	3300	mg/kg		J
01-VBOU3-SB-0025-A	D3L190464016	Soil	Field		Total	Vanadium	66	mg/kg		J
01-VBOU3-SB-0025-A	D3L190464016	Soil	Field		Total	Zinc	76	mg/kg		J
01-VBOU3-SB-0025-B	D3L190464017	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0025-B	D3L190464017	Soil	Field		Total	Chromium	6.5	mg/kg		J
01-VBOU3-SB-0025-B	D3L190464017	Soil	Field		Total	Sodium	1700	mg/kg		J
01-VBOU3-SB-0025-B	D3L190464017	Soil	Field		Total	Vanadium	66	mg/kg		J
01-VBOU3-SB-0025-B	D3L190464017	Soil	Field		Total	Zinc	68	mg/kg		J
01-VBOU3-SB-0026-A	D3L190461008	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0026-A	D3L190461008	Soil	Field		Total	Manganese	220	mg/kg		J
01-VBOU3-SB-0026-A	D3L190461008	Soil	Field		Total	Vanadium	33	mg/kg		J
01-VBOU3-SB-0026-B	D3L190461009	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0026-B	D3L190461009	Soil	Field		Total	Manganese	520	mg/kg		J
01-VBOU3-SB-0026-B	D3L190461009	Soil	Field		Total	Vanadium	35	mg/kg		J
01-VBOU3-SB-0026-C	D3L190461010	Soil	Field QC	Duplicate	Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0026-C	D3L190461010	Soil	Field QC	Duplicate	Total	Manganese	760	mg/kg		J
01-VBOU3-SB-0026-C	D3L190461010	Soil	Field QC	Duplicate	Total	Vanadium	36	mg/kg		J
01-VBOU3-SB-0027-A	D3L190390003	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0027-A	D3L190390003	Soil	Field		Total	Lead	19	mg/kg		J

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0027-A	D3L190390003	Soil	Field		Total	Manganese	300	mg/kg	L	J
01-VBOU3-SB-0027-A	D3L190390003	Soil	Field		Total	Zinc	62	mg/kg		J
01-VBOU3-SB-0027-B	D3L190390004	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0027-B	D3L190390004	Soil	Field		Total	Lead	40	mg/kg		J
01-VBOU3-SB-0027-B	D3L190390004	Soil	Field		Total	Manganese	650	mg/kg	L	J
01-VBOU3-SB-0027-B	D3L190390004	Soil	Field		Total	Zinc	130	mg/kg		J
01-VBOU3-SB-0027-C	D3L190390005	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0027-C	D3L190390005	Soil	Field		Total	Lead	9.2	mg/kg		J
01-VBOU3-SB-0027-C	D3L190390005	Soil	Field		Total	Manganese	420	mg/kg	L	J
01-VBOU3-SB-0027-C	D3L190390005	Soil	Field		Total	Zinc	64	mg/kg		J
01-VBOU3-SB-0027-D	D3L190390006	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0027-D	D3L190390006	Soil	Field		Total	Lead	11	mg/kg		J
01-VBOU3-SB-0027-D	D3L190390006	Soil	Field		Total	Manganese	380	mg/kg	L	J
01-VBOU3-SB-0027-D	D3L190390006	Soil	Field		Total	Zinc	67	mg/kg		J
01-VBOU3-SB-0027-E	D3L190390007	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0027-E	D3L190390007	Soil	Field		Total	Lead	16	mg/kg		J
01-VBOU3-SB-0027-E	D3L190390007	Soil	Field		Total	Manganese	640	mg/kg	L	J
01-VBOU3-SB-0027-E	D3L190390007	Soil	Field		Total	Zinc	63	mg/kg		J
01-VBOU3-SB-0028-A	D3L100414001	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0028-A	D3L100414001	Soil	Field		Total	Barium	36	mg/kg	L	J
01-VBOU3-SB-0028-A	D3L100414001	Soil	Field		Total	Zinc	49	mg/kg		J
01-VBOU3-SB-0028-B	D3L100414002	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0028-B	D3L100414002	Soil	Field		Total	Barium	210	mg/kg	L	J
01-VBOU3-SB-0028-B	D3L100414002	Soil	Field		Total	Zinc	65	mg/kg		J
01-VBOU3-SB-0028-C	D3L100414003	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0028-C	D3L100414003	Soil	Field		Total	Barium	32	mg/kg	L	J
01-VBOU3-SB-0028-C	D3L100414003	Soil	Field		Total	Zinc	65	mg/kg		J
01-VBOU3-SB-0028-D	D3L100414004	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0028-D	D3L100414004	Soil	Field		Total	Barium	38	mg/kg	L	J
01-VBOU3-SB-0028-D	D3L100414004	Soil	Field		Total	Zinc	58	mg/kg		J
01-VBOU3-SB-0028-E	D3L100414005	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0028-E	D3L100414005	Soil	Field		Total	Barium	30	mg/kg	L	J
01-VBOU3-SB-0028-E	D3L100414005	Soil	Field		Total	Zinc	52	mg/kg		J
01-VBOU3-SB-0029-A	D3L100414006	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0029-A	D3L100414006	Soil	Field		Total	Barium	49	mg/kg	L	J
01-VBOU3-SB-0029-A	D3L100414006	Soil	Field		Total	Zinc	68	mg/kg		J
01-VBOU3-SB-0029-B	D3L100414007	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0029-B	D3L100414007	Soil	Field		Total	Barium	35	mg/kg	L	J
01-VBOU3-SB-0029-B	D3L100414007	Soil	Field		Total	Zinc	57	mg/kg		J
01-VBOU3-SB-0029-C	D3L100414008	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0029-C	D3L100414008	Soil	Field		Total	Barium	35	mg/kg	L	J
01-VBOU3-SB-0029-C	D3L100414008	Soil	Field		Total	Zinc	55	mg/kg		J
01-VBOU3-SB-0029-D	D3L100414009	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0029-D	D3L100414009	Soil	Field		Total	Barium	29	mg/kg	L	J
01-VBOU3-SB-0029-D	D3L100414009	Soil	Field		Total	Zinc	50	mg/kg		J
01-VBOU3-SB-0029-E	D3L100414010	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0029-E	D3L100414010	Soil	Field		Total	Barium	41	mg/kg	L	J
01-VBOU3-SB-0029-E	D3L100414010	Soil	Field		Total	Zinc	77	mg/kg		J
01-VBOU3-SB-0030-A	D3L110408020	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0030-A	D3L110408020	Soil	Field		Total	Lead	22	mg/kg		J
01-VBOU3-SB-0030-A	D3L110408020	Soil	Field		Total	Manganese	260	mg/kg		J
01-VBOU3-SB-0030-B	D3L190390001	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0030-B	D3L190390001	Soil	Field		Total	Lead	15	mg/kg		J
01-VBOU3-SB-0030-B	D3L190390001	Soil	Field		Total	Manganese	370	mg/kg	L	J
01-VBOU3-SB-0030-B	D3L190390001	Soil	Field		Total	Zinc	53	mg/kg		J
01-VBOU3-SB-0030-C	D3L190390002	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0030-C	D3L190390002	Soil	Field		Total	Lead	6.4	mg/kg		J
01-VBOU3-SB-0030-C	D3L190390002	Soil	Field		Total	Manganese	190	mg/kg	L	J
01-VBOU3-SB-0030-C	D3L190390002	Soil	Field		Total	Zinc	37	mg/kg		J
01-VBOU3-SB-0031-A	D3L110408006	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0031-A	D3L110408006	Soil	Field		Total	Lead	17	mg/kg		J
01-VBOU3-SB-0031-A	D3L110408006	Soil	Field		Total	Manganese	310	mg/kg		J
01-VBOU3-SB-0031-B	D3L110408007	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0031-B	D3L110408007	Soil	Field		Total	Lead	14	mg/kg		J

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0031-B	D3L110408007	Soil	Field		Total	Manganese	280	mg/kg		J
01-VBOU3-SB-0031-C	D3L110408008	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0031-C	D3L110408008	Soil	Field		Total	Lead	10	mg/kg		J
01-VBOU3-SB-0031-C	D3L110408008	Soil	Field		Total	Manganese	270	mg/kg		J
01-VBOU3-SB-0032-A	D3L190390008	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0032-A	D3L190390008	Soil	Field		Total	Lead	110	mg/kg		J
01-VBOU3-SB-0032-A	D3L190390008	Soil	Field		Total	Manganese	330	mg/kg	L	J
01-VBOU3-SB-0032-A	D3L190390008	Soil	Field		Total	Zinc	130	mg/kg		J
01-VBOU3-SB-0032-B	D3L190390009	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0032-B	D3L190390009	Soil	Field		Total	Lead	230	mg/kg		J
01-VBOU3-SB-0032-B	D3L190390009	Soil	Field		Total	Manganese	320	mg/kg	L	J
01-VBOU3-SB-0032-B	D3L190390009	Soil	Field		Total	Zinc	130	mg/kg		J
01-VBOU3-SB-0032-C	D3L190390010	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0032-C	D3L190390010	Soil	Field		Total	Lead	21	mg/kg		J
01-VBOU3-SB-0032-C	D3L190390010	Soil	Field		Total	Manganese	240	mg/kg	L	J
01-VBOU3-SB-0032-C	D3L190390010	Soil	Field		Total	Zinc	58	mg/kg		J
01-VBOU3-SB-0032-D	D3L190390011	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0032-D	D3L190390011	Soil	Field		Total	Lead	24	mg/kg		J
01-VBOU3-SB-0032-D	D3L190390011	Soil	Field		Total	Manganese	370	mg/kg	L	J
01-VBOU3-SB-0032-D	D3L190390011	Soil	Field		Total	Zinc	77	mg/kg		J
01-VBOU3-SB-0032-E	D3L190390012	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0032-E	D3L190390012	Soil	Field		Total	Lead	18	mg/kg		J
01-VBOU3-SB-0032-E	D3L190390012	Soil	Field		Total	Manganese	150	mg/kg	L	J
01-VBOU3-SB-0032-E	D3L190390012	Soil	Field		Total	Zinc	75	mg/kg		J
01-VBOU3-SB-0033-A	D3L190464001	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0033-A	D3L190464001	Soil	Field		Total	Chromium	13	mg/kg		J
01-VBOU3-SB-0033-A	D3L190464001	Soil	Field		Total	Sodium	530	mg/kg		J
01-VBOU3-SB-0033-A	D3L190464001	Soil	Field		Total	Vanadium	32	mg/kg		J
01-VBOU3-SB-0033-A	D3L190464001	Soil	Field		Total	Zinc	65	mg/kg		J
01-VBOU3-SB-0033-B	D3L190464002	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0033-B	D3L190464002	Soil	Field		Total	Chromium	16	mg/kg		J
01-VBOU3-SB-0033-B	D3L190464002	Soil	Field		Total	Vanadium	31	mg/kg		J
01-VBOU3-SB-0033-B	D3L190464002	Soil	Field		Total	Zinc	55	mg/kg		J
01-VBOU3-SB-0033-C	D3L190464003	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0033-C	D3L190464003	Soil	Field		Total	Chromium	13	mg/kg		J
01-VBOU3-SB-0033-C	D3L190464003	Soil	Field		Total	Vanadium	23	mg/kg		J
01-VBOU3-SB-0033-C	D3L190464003	Soil	Field		Total	Zinc	33	mg/kg		J
01-VBOU3-SB-0033-D	D3L190464004	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0033-D	D3L190464004	Soil	Field		Total	Chromium	2.2	mg/kg		J
01-VBOU3-SB-0033-D	D3L190464004	Soil	Field		Total	Lead	1.7	mg/kg		U
01-VBOU3-SB-0033-D	D3L190464004	Soil	Field		Total	Potassium	330	mg/kg		U
01-VBOU3-SB-0033-D	D3L190464004	Soil	Field		Total	Vanadium	4.6	mg/kg		J
01-VBOU3-SB-0033-D	D3L190464004	Soil	Field		Total	Zinc	25	mg/kg		J
01-VBOU3-SB-0033-E	D3L190464005	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0033-E	D3L190464005	Soil	Field		Total	Chromium	13	mg/kg		J
01-VBOU3-SB-0033-E	D3L190464005	Soil	Field		Total	Sodium	720	mg/kg		J
01-VBOU3-SB-0033-E	D3L190464005	Soil	Field		Total	Vanadium	29	mg/kg		J
01-VBOU3-SB-0033-E	D3L190464005	Soil	Field		Total	Zinc	67	mg/kg		J
01-VBOU3-SB-0034-A	D3L190419015	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0034-A	D3L190419015	Soil	Field		Total	Barium	430	mg/kg		J
01-VBOU3-SB-0034-A	D3L190419015	Soil	Field		Total	Lead	19	mg/kg		J
01-VBOU3-SB-0034-A	D3L190419015	Soil	Field		Total	Manganese	770	mg/kg		J
01-VBOU3-SB-0034-B	D3L190419016	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0034-B	D3L190419016	Soil	Field		Total	Barium	250	mg/kg		J
01-VBOU3-SB-0034-B	D3L190419016	Soil	Field		Total	Lead	12	mg/kg		J
01-VBOU3-SB-0034-B	D3L190419016	Soil	Field		Total	Manganese	270	mg/kg		J
01-VBOU3-SB-0034-C	D3L190419017	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0034-C	D3L190419017	Soil	Field		Total	Barium	73	mg/kg		J
01-VBOU3-SB-0034-C	D3L190419017	Soil	Field		Total	Lead	12	mg/kg		J
01-VBOU3-SB-0034-C	D3L190419017	Soil	Field		Total	Manganese	250	mg/kg		J
01-VBOU3-SB-0034-D	D3L190419018	Soil	Field QC	Duplicate	Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0034-D	D3L190419018	Soil	Field QC	Duplicate	Total	Barium	67	mg/kg		J
01-VBOU3-SB-0034-D	D3L190419018	Soil	Field QC	Duplicate	Total	Lead	10	mg/kg		J
01-VBOU3-SB-0034-D	D3L190419018	Soil	Field QC	Duplicate	Total	Manganese	220	mg/kg		J

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-SB-0034-E	D3L190419019	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0034-E	D3L190419019	Soil	Field		Total	Barium	670	mg/kg		J
01-VBOU3-SB-0034-E	D3L190419019	Soil	Field		Total	Lead	4.1	mg/kg		J
01-VBOU3-SB-0034-E	D3L190419019	Soil	Field		Total	Manganese	92	mg/kg		J
01-VBOU3-SB-0034-F	D3L190419020	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0034-F	D3L190419020	Soil	Field		Total	Barium	51	mg/kg		J
01-VBOU3-SB-0034-F	D3L190419020	Soil	Field		Total	Lead	12	mg/kg		J
01-VBOU3-SB-0034-F	D3L190419020	Soil	Field		Total	Manganese	340	mg/kg		J
01-VBOU3-SB-0035-A	D3L190464009	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0035-A	D3L190464009	Soil	Field		Total	Chromium	12	mg/kg		J
01-VBOU3-SB-0035-A	D3L190464009	Soil	Field		Total	Vanadium	22	mg/kg		J
01-VBOU3-SB-0035-A	D3L190464009	Soil	Field		Total	Zinc	70	mg/kg		J
01-VBOU3-SB-0035-B	D3L190464010	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0035-B	D3L190464010	Soil	Field		Total	Chromium	4.5	mg/kg		J
01-VBOU3-SB-0035-B	D3L190464010	Soil	Field		Total	Vanadium	8.9	mg/kg		J
01-VBOU3-SB-0035-B	D3L190464010	Soil	Field		Total	Zinc	55	mg/kg		J
01-VBOU3-SB-0035-C	D3L190464011	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0035-C	D3L190464011	Soil	Field		Total	Chromium	9.1	mg/kg		J
01-VBOU3-SB-0035-C	D3L190464011	Soil	Field		Total	Vanadium	25	mg/kg		J
01-VBOU3-SB-0035-C	D3L190464011	Soil	Field		Total	Zinc	73	mg/kg		J
01-VBOU3-SB-0036-A	D3L190461005	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0036-A	D3L190461005	Soil	Field		Total	Manganese	240	mg/kg		J
01-VBOU3-SB-0036-A	D3L190461005	Soil	Field		Total	Vanadium	30	mg/kg		J
01-VBOU3-SB-0036-B	D3L190461006	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0036-B	D3L190461006	Soil	Field		Total	Manganese	290	mg/kg		J
01-VBOU3-SB-0036-B	D3L190461006	Soil	Field		Total	Vanadium	26	mg/kg		J
01-VBOU3-SB-0036-C	D3L190461007	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0036-C	D3L190461007	Soil	Field		Total	Manganese	240	mg/kg		J
01-VBOU3-SB-0036-C	D3L190461007	Soil	Field		Total	Vanadium	30	mg/kg		J
01-VBOU3-SB-0037-A	D3L190464006	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0037-A	D3L190464006	Soil	Field		Total	Chromium	13	mg/kg		J
01-VBOU3-SB-0037-A	D3L190464006	Soil	Field		Total	Vanadium	31	mg/kg		J
01-VBOU3-SB-0037-A	D3L190464006	Soil	Field		Total	Zinc	130	mg/kg		J
01-VBOU3-SB-0037-B	D3L190464007	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0037-B	D3L190464007	Soil	Field		Total	Chromium	18	mg/kg		J
01-VBOU3-SB-0037-B	D3L190464007	Soil	Field		Total	Sodium	960	mg/kg		J
01-VBOU3-SB-0037-B	D3L190464007	Soil	Field		Total	Vanadium	34	mg/kg		J
01-VBOU3-SB-0037-B	D3L190464007	Soil	Field		Total	Zinc	100	mg/kg		J
01-VBOU3-SB-0037-C	D3L190464008	Soil	Field		Total	Antimony	ND	mg/kg		UJ
01-VBOU3-SB-0037-C	D3L190464008	Soil	Field		Total	Chromium	10	mg/kg		J
01-VBOU3-SB-0037-C	D3L190464008	Soil	Field		Total	Sodium	720	mg/kg		J
01-VBOU3-SB-0037-C	D3L190464008	Soil	Field		Total	Vanadium	24	mg/kg		J
01-VBOU3-SB-0037-C	D3L190464008	Soil	Field		Total	Zinc	41	mg/kg		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Arsenic	11600	ug/l		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Beryllium	26.1	ug/l		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Cadmium	7400	ug/l		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Lead	15800	ug/l		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Selenium	39.4	ug/l		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Silver	219	ug/l		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Thallium	300	ug/l		J
01-VBOU3-GW-0002	8-211149	Water	Field		Total	Vanadium	541	ug/l		J
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Arsenic	12.2	ug/l	B	J
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Beryllium	Non-detect	ug/l	U	UJ
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Cadmium	908	ug/l		J
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Lead	42.6	ug/l		J
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Mercury	0.099	ug/l	B	U
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Selenium	11	ug/l	B	J
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Silver	2.19	ug/l	B	J
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Thallium	4.68	ug/l		J
01-VBOU3-GW-0003	8-211136	Water	Field		Total	Vanadium	47.4	ug/l	B	J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Arsenic	41.4	ug/l		J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Beryllium	22.1	ug/l		J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Cadmium	24.8	ug/l		J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Calcium	90	ug/l		U

Table 3-8. Validation Qualifiers Assigned to Phase I Sample Results (Continued)

Sample ID	Lab Sample ID	Media	Sample Type	QC Type	Analyte Type	Anayte	Result	Units	Data Qualifiers	
									Laboratory	Validation
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Lead	19.1	ug/l		J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Manganese	89.4	ug/l		U
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Nickel	6.3	ug/l	B	U
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Selenium	83.4	ug/l		J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Silver	35.2	ug/l		J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Sodium	100	ug/l	B	J
01-VBOU3-GW-0005	8-246851	Water	Field QC	PE Std	Total	Thallium	30	ug/l		J
01-VBOU3-RIN-0001	D3L100414021	Water	Field QC	Rinsate	Total	Antimony	ND	ug/L		R
01-VBOU3-RIN-0001	D3L100414021	Water	Field QC	Rinsate	Total	Iron	220	ug/L		J
01-VBOU3-RIN-0003	D3L190390021	Water	Field QC	Rinsate	Total	Mercury	ND	ug/L		R
MW-33-050304		WATER	Field		Total	Antimony	ND	ug/L		UJ
MW-33-052104		WATER	Field		Total	Aluminum	580	ug/L		J
MW-33-052104		WATER	Field		Total	Arsenic	1.9	ug/L		J
MW-34-052104		WATER	Field		Dissolved	Cadmium	5.9	ug/L		J
MW-34-052104		WATER	Field		Dissolved	Silver	ND	ug/L		UJ
MW-34-052104		WATER	Field		Dissolved	Vanadium	ND	ug/L		UJ
MW-34-052104		WATER	Field		Total	Aluminum	260	ug/L		J
MW-34-052104		WATER	Field		Total	Cadmium	7.5	ug/L		J
MW-34-052104		WATER	Field		Total	Silver	ND	ug/L		UJ
MW-34-052104		WATER	Field		Total	Vanadium	ND	ug/L		UJ
MW-36-052104		WATER	Field		Total	Aluminum	1300	ug/L		J
MW-36-052104		WATER	Field		Total	Arsenic	10	ug/L		J
KP-GW-16-111904	D4K190487001	WATER	Field		Total	Aluminum	220	ug/L		J
KP-GW-16-111904	D4K190487001	WATER	Field		Total	Zinc	150	ug/L		J
KP-GW-15-111904	D4K190487002	WATER	Field		Total	Zinc	120	ug/L		J
KP-GW-17-111904	D4K190487003	WATER	Field		Total	Aluminum	3500	ug/L		J
KP-GW-17-111904	D4K190487003	WATER	Field		Total	Zinc	61	ug/L		J
MW-31-111904	D4K190487004	WATER	Field QC	Rinsate	Total	Zinc	ND	ug/L		UJ
KP-GW-46-111904	D4K190487005	WATER	Field		Total	Zinc	170	ug/L		J
KP-GW-46-111904A	D4K190487006	WATER	Field QC	Duplicate	Total	Zinc	160	ug/L		J
MW-30-111904	D4K190487007	WATER	Field QC	PE Std	Total	Zinc	120	ug/L		J
MW-30-111904	D4K190487007	WATER	Field QC	PE Std	Total	Beryllium	22	ug/L		J
PS-7-050205	D5E020222001	WATER	Field		Total	Antimony	ND	ug/L		R
PS-7-050205	D5E020222001	WATER	Field		Total	Arsenic	47	ug/L		J
PS-7-050205	D5E020222001	WATER	Field		Total	Beryllium	7.8	ug/L		J
PS-6-050205	D5E020222002	WATER	Field		Total	Antimony	ND	ug/L		R
PS-6-050205	D5E020222002	WATER	Field		Total	Arsenic	2.8	ug/L		J
PS-6-050205	D5E020222002	WATER	Field		Total	Beryllium	ND	ug/L		UJ
PS-5-050205	D5E020222003	WATER	Field		Total	Antimony	ND	ug/L		R
PS-5-050205	D5E020222003	WATER	Field		Total	Arsenic	15	ug/L		J
PS-5-050205	D5E020222003	WATER	Field		Total	Beryllium	4.4	ug/L		J
MW-31-050205	D5E020222004	WATER	Field QC	Rinsate	Total	Antimony	ND	ug/L		R
MW-31-050205	D5E020222004	WATER	Field QC	Rinsate	Total	Arsenic	ND	ug/L		J
MW-31-050205	D5E020222004	WATER	Field QC	Rinsate	Total	Beryllium	ND	ug/L		UJ
MW-30-050205	D5E020222005	WATER	Field QC	PE Std	Total	Antimony	34	ug/L	J	J
MW-30-050205	D5E020222005	WATER	Field QC	PE Std	Total	Arsenic	11	ug/L	J	J
MW-30-050205	D5E020222005	WATER	Field QC	PE Std	Total	Beryllium	6.2	ug/L	J	J
PS-3-050205	D5E020222006	WATER	Field		Total	Antimony	ND	ug/L		R
PS-3-050205	D5E020222006	WATER	Field		Total	Arsenic	60	ug/L		J
PS-3-050205	D5E020222006	WATER	Field		Total	Beryllium	29	ug/L		J
PS-4-050205	D5E020222007	WATER	Field		Total	Antimony	ND	ug/L		R
PS-4-050205	D5E020222007	WATER	Field		Total	Arsenic	4.3	ug/L		J
PS-4-050205	D5E020222007	WATER	Field		Total	Beryllium	1.2	ug/L		J
PS-1-050205	D5E020222008	WATER	Field		Total	Antimony	ND	ug/L		R
PS-1-050205	D5E020222008	WATER	Field		Total	Arsenic	28	ug/L		J
PS-1-050205	D5E020222008	WATER	Field		Total	Beryllium	4.4	ug/L		J

B = Reported value is less than contract required detection limit (CRDL) but greater than instrument detection limit (IDL).
J = Numerical value is an estimated quantity because the Quality Control criteria were not met.
L = Physical and chemical interferences are present.
U = Analyzed but not detected above the level of the associated value (either sample detection limit or sample quantiation limit)
UJ = The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.
R = Reported value is "rejected".

Table 3-9. Data Qualifiers and Data Usability

Data Qualifier (see below)		Rule for Data Use (USEPA 1989)
Laboratory	**Validation**	
None	None	Use
None	J, U, or UJ	Use
B	None, J or N	Use
B	U	Use ½ reported detection limit
L	None or J	Use
J	U or UJ	Use ½ reported detection limit
U or UJ or BU	None or J	Use ½ reported detection limit
U	R	Do not use

Meaning of Laboratory Qualifiers for Inorganic Data

B = Reported value is <Contract Required Detection Limit, but > Instrument Detection Limit
U = Compound was analyzed for, but not detected
E = Value is estimated due to matrix interferences
J = Estimated value
N = Spiked sample recovery not within control limits
L = Physical and chemical interferences are present

Meaning of Validation Qualifier

J = Estimated value
U = Material was analyzed for, bot not detected
E = Concentration exceeds calibration range of GC/MS instrument
N = Presumptive evidence of presence of material (Tentatively Identified Compounds)
R = Quality Control indicates that data are unusable

Source: USEPA (1989), unless otherwise noted

Table 4-1. Background Concentration of Metals in Soil (mg/kg)

Chemical	Concentration (mg/kg)	Source
Aluminum	230918	Shacklette and Boerngen, 1984
Antimony	10	Dragun, 1988
Arsenic	12.7	Shacklette and Boerngen, 1984
Barium	1797	Shacklette and Boerngen, 1984
Beryllium	8.7	Shacklette and Boerngen, 1984
Cadmium	7.0	Dragun, 1988
Calcium	164986	Shacklette and Boerngen, 1984
Chromium	108	Shacklette and Boerngen, 1984
Cobalt	27.3	Shacklette and Boerngen, 1984
Copper	73.3	Shacklette and Boerngen, 1984
Iron	72973	Shacklette and Boerngen, 1984
Lead	167.8	Shacklette and Boerngen, 1984
Magnesium	18099	Shacklette and Boerngen, 1984
Manganese	1493.7	Shacklette and Boerngen, 1984
Mercury	0.96	Shacklette and Boerngen, 1984
Nickel	35	Shacklette and Boerngen, 1984
Potassium	67031	Shacklette and Boerngen, 1984
Selenium	1.4	Shacklette and Boerngen, 1984
Silver	5	Dragun, 1988
Sodium	31988	Shacklette and Boerngen, 1984
Thallium	12	Dragun, 1988
Vanadium	142	Shacklette and Boerngen, 1984
Zinc	497	Shacklette and Boerngen, 1984

Dragun, 1988. (Concentration is the upper end of the typical range of concentrations found in native soils in the US).

Shacklette and Boerngen, 1984. (Concentration is 99th percentile of the distribution of concentrations calculated from soil data collected from 7 counties in Colorado surrounding the Denver Metro Area).

Table 4-2. Comparison of Inorganic Chemicals in Site Soil Samples to Background Concentrations

Chemical	Number of Exceedences	Total Number of Samples	Frequency of Exceedences
Aluminum	0	123	0%
Antimony	1	123	1%
Arsenic	15	123	**12%**
Barium	1	123	1%
Beryllium	0	123	0%
Cadmium	12	123	**10%**
Calcium	0	123	0%
Chromium	0	123	0%
Cobalt	1	123	1%
Copper	21	123	**17%**
Iron	2	123	**2%**
Lead	11	123	**9%**
Magnesium	0	123	0%
Manganese	2	123	**2%**
Mercury	3	123	**2%**
Nickel	5	123	**4%**
Potassium	0	123	0%
Selenium	2	123	**2%**
Sodium	0	123	0%
Silver	4	123	**3%**
Thallium	0	123	0%
Vanadium	0	123	0%
Zinc	7	123	**6%**

Boldface indicates a frequency greater than 1%

Shading indicates a frequency greater than 5%

Table 4-3. Arsenic and Lead Concentrations in Site Soils Surrounding Sample SB-007-C

Soil Boring	Sample	Arsenic (mg/kg)	Lead (mg/kg)
002	01-VBOU3-SB-0002-A	5.1	8.9
	01-VBOU3-SB-0002-B	3.7	9
	01-VBOU3-SB-0002-C	1.1	30
	01-VBOU3-SB-0002-D	6.9	7.1
006	01-VBOU3-SB-0006-A	11	110
	01-VBOU3-SB-0006-B	29	170
	01-VBOU3-SB-0006-C	3.9	18
007	01-VBOU3-SB-0007-A	1.1	8.9
	01-VBOU3-SB-0007-B	24	430
	01-VBOU3-SB-0007-C	2900	1600
	01-VBOU3-SB-0007-D	11	32
	01-VBOU3-SB-0007-E	4.7	17
008	01-VBOU3-SB-0008-A	9.5	400
	01-VBOU3-SB-0008-B	17	160
	01-VBOU3-SB-0008-C	1.3	17
	01-VBOU3-SB-0008-D	0.5	40
015	01-VBOU3-SB-0015-A	3.5	280
	01-VBOU3-SB-0015-B	2.6	24
	01-VBOU3-SB-0015-C	0.5	18
017	01-VBOU3-SB-0017-A	2.5	43
	01-VBOU3-SB-0017-B	2	7.2
	01-VBOU3-SB-0017-C	5.7	16
	01-VBOU3-SB-0017-D	0.5	3.4
018	01-VBOU3-SB-0018-A	2.6	44
	01-VBOU3-SB-0018-B	3.6	12
	01-VBOU3-SB-0018-C	3	7.8

Table 4-4. Water Levels and Saturated Thickness in the Potential Alluvial Aquifer at the VBI70 OU3 Site
June - July, 2004

Well	Date	Depth to Bedrock (ft bgs)	Depth to Water (ft bgs)	Saturated Thickness of Alluvium (ft)	Groundwater Elevation (ft amsl)
MW-33	7/1/2004	16.5	15.6	0.9	5,183.1
	7/28/2004	16.5	15.7	0.8	5,183
MW-34	7/1/2004	20.2	20	0.2	5,179.8
	7/28/2004	20.2	19.8	0.4	5,180
MW-35	7/1/2004	11	--	NA	--
	7/28/2004	11	11.2	NA	--
MW-36	7/1/2004	8	8.9	NA	5,166.5
	7/28/2004	8	8.4	NA	5,166.4

ft amsl = feet above mean sea level
ft bgs = feet below ground surface
NS = No Sample
NA = Not applicable, depth to water exceeds depth to bedrock (no measureable saturated thickness)

Source: USEPA 2004b

Table 4-5. Comparison of Dissolved Metals in Site Groundwater to MCLs

all concentrations are in ug/L

Site	Location	Sample	Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Maximum Contaminant Level (MCL)				200	6	10	2000	4	5	--	100	--	1300	300	15	--	50	2	--	--	50	100	--	2	--	5000
ON-SITE	SB-04	01-VBOU3-GW-0004	12/18/03	63 2	1	3 25	36 4	0 5	1,770	375,600	1	35.8	30.8	261	1.35	48,300	6,420	0.03	30.3	9,910	7.06	0.2	677,000	2 03	12.1	10300
	SB-07	01-VBOU3-GW-0001	12/12/03	108	2 48	32 8	25	0 5	8 73	382,000	1	13 8	4	25800	2.3	60,900	6,190	0.03	36 6	14,400	10 8	0 2	764,000	0.62	12 5	1240
	MW-32	MW-32-070104	7/1/04	50	1	1.7	55	0.5	0 5	190,000	5	11	16	50	1.5	24,000	71	0 1	20	1,500	7.5	5	590,000	0 5	5	10
		MW-32-072804	7/28/04	50	1	2.9	48	0.5	0.5	140,000	5	20	5	3000	1.5	18,000	610	0.1	20	1,500	7.5	5	440 000	0 5	5	10
	MW-33	MW 33-050304	5/3/04	60	1	2	24	0.5	09	74,000	5	16	5	50	1.5	7,400	1,200	0.1	20	1,500	7.5	5	120,000	0.5	5	190
		MW-33-052104	5/21/04	50	1	2	23	0.5	40	66,000	5	5	5	50	1.5	6,600	450	0 1	20	1,500	7.5	5	88,000	0 5	5	180
		MW-33-070104	7/1/04	50	1	2.8	26	0.5	28	73,000	5	5	5	50	1.5	7,000	15	0 1	20	1,500	7.5	5	92,000	0 5	5	200
		MW-33-072804	7/28/04	50	1	2.2	35	0.5	34	100,000	5	5	5	50	1.5	10,000	5	0.1	20	1,500	7.5	5	120,000	0 5	5	260
	MW-34	MW-34-052104	5/21/04	50	1	1	82	0.5	5.9	630,000	5	5	11	180	1.5	57,000	640	0.1	20	12,000	7.5	5	680,000	0 5	5	45
		MW-34-070104	7/1/04	50	1	1.3	48	0.5	2.1	540,000	5	5	5	50	1.5	61,000	98	0 1	20	9,400	7.5	5	630,000	0.5	5	10
		MW-34-072804	7/28/04	50	1	0.5	36	0.5	1.8	380,000	5	5	5	50	1.5	42,000	23	0.1	20	7,300	7.5	5	540,000	0.5	5	10
	MW-35	MW-35-052404	5/24/04	50	1	1	78	0.5	3	120,000	5	5	5	50	1.5	14,000	11	0.1	20	4,100	7.5	5	140,000	0.5	5	10
		MW-35-072804	7/28/04	50	1	1	110	0.5	3.6	120,000	5	5	5	50	1.5	14,000	5	0.1	20	4,200	7.5	5	140,000	0.5	5	23
	MW-36	MW-36-052404	5/24/04	50	1	6	110	0.5	47	430,000	5	11	27	150	1.5	50,000	3,800	0.1	20	8,700	7.5	5	380,000	0.5	5	98
		MW-36-070104	7/1/04	50	1	9.2	100	0 5	28	410,000	5	5	22	50	1.5	46,000	1,900	0.1	20	8,000	7.5	5	380,000	0.5	5	140
		MW-36-072804	7/28/04	50	1	6.1	88	0 5	53	450,000	5	5	22	50	1.5	51,000	540	0.1	20	8,200	7.5	5	420,000	0 5	5	110
OFF-SITE	PS-1	PS-1-050205	5/2/05	190	1	0.5	65	0.5	0 5	65,000	5	5	5	150	1.5	12,000	360	0.1	20	8,600	7.5	5	330,000	0 5	5	10
	PS-3	PS-3-050205	5/2/05	50	1	1.3	210	0.5	0 5	290,000	5	5	5	180	1.5	51,000	330	0 1	20	11,000	7.5	5	390,000	0 5	5	10
	PS-4	PS-4-050205	5/2/05	50	1	1.1	150	0 5	0.5	200,000	5	5	5	300	1.5	36,000	140	0.1	20	8,000	7.5	5	240,000	0.5	5	10
	PS-7	PS-7-050205	5/2/05	50	1	2.8	64	0 5	83	640,000	5	5	5	50	1.5	83,000	100	0.1	20	8,500	7.5	5	660,000	0.5	5	360
	PS-6	PS-6-050205	5/2/05	50	1	0.5	76	0.5	62	250,000	5	5	5	50	1.5	40,000	190	0.1	20	9 100	7 5	5	400,000	0.5	5	250
	PS-5	PS-5-050205	5/2/05	50	1	0 5	130	0.5	22	220,000	5	20	5	1000	7	39,000	470	0.1	20	9,000	7 5	5	330,000	0.5	5	180
	PS-19	KP-PS-19-091905	9/19/2005	50	1	0.5	120	0.5	0.5	130,000	5	5	5	120	1.5	28,000	270	0.1	20	24,000	7.5	5	180,000	0 5	5	20
	GW-46	GW-46_6-17-87	6/17/1987	--	--	9.3	--	--	22	--	--	--	--	--	3 2	--	--	--	--	--	--	--	--	--	--	107
		GW-46_9-1-87	9/1/1987	--	--	5.7	--	--	28	--	--	--	--	--	3.8	--	--	--	--	--	--	--	--	--	--	164
		GW-46_9-30-87	9/30/1987	--	--	3	--	--	22	--	--	--	--	--	16	--	--	--	--	--	--	--	--	--	--	185
		GW-46_10-22-87	10/22/1987	--	--	3	--	--	22	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	216
		GW-46_11-23-87	11/23/1987	--	--	3	--	--	15	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	156
		GW-46_12-30-87	12/30/1987	--	--	3	--	--	18	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	170
		GW-46_9-17-1993	9/17/1993	--	--	2.5	--	--	18	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	180
		GW-46_11-18-1993	11/18/1993	--	--	2.5	--	--	23	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	150
		GW-46_2-24-1994	2/24/1994	--	--	2.5	--	--	14	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	181
		GW-46_5-26-1994	5/26/1994	--	--	2.5	--	--	19	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	183
		GW-46_9-8-1994	9/8/1994	--	--	2.5	--	--	23	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	180
		GW-46_11-2-1994	11/2/1994	--	--	2.5	--	--	18	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	170
		GW-46_2-22-1995	2/22/1995	--	--	2.5	--	--	20	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	180
		GW-46_5-23-1995	5/23/1995	--	--	2.5	--	--	17	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	177
		GW-46_8-9-1995	8/9/1995	--	--	2.5	--	--	25	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	236
		GW-46_11-9-1995	11/9/1995	--	--	2.5	--	--	26	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	268
		GW-46_3-7-1996	3/7/1996	--	--	2.5	--	--	32	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	242
		GW-46_6-24-1996	6/24/1996	--	--	2.5	--	--	25	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	215

Table 4-5. Comparison of Dissolved Metals in Site Groundwater to MCLs

all concentrations are in ug/L

Site	Location	Sample	Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Maximum Contaminant Level (MCL)				200	6	10	2000	4	5	--	100	--	1300	300	15	--	50	2	--	--	50	100	--	2	--	5000
OFF-SITE	GW-46	GW-46_8-28-1996	8/28/1996	--	--	7	--	--	25	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	216
		GW-46_11-21-1996	11/21/1996	--	--	5	--	--	28	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	251
		GW-46_3-12-1997	3/12/1997	--	--	2.5	--	--	27	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	221
		GW-46_6-24-1997	6/24/1997	--	--	2.5	--	--	27	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	168
		GW-46_9-24-1997	9/24/1997	--	--	2.5	--	--	26	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	228
		GW-46_11-19-1997	11/19/1997	--	--	2.5	--	--	25	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	196
		GW-46_3-3-1998	3/3/1998	--	--	2.5	--	--	30	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	288
		GW-46_6-2-1998	6/2/1998	--	--	2.5	--	--	36	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	212
		GW-46_8-26-1998	8/26/1998	--	--	2.5	--	--	27	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	162
		GW-46_11-23-1998	11/23/1998	--	--	2.5	--	--	45	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	192
		GW-46_2-16-1999	2/16/1999	--	--	2.5	--	--	28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	253
		GW-46_5-25-1999	5/25/1999	--	--	2.5	--	--	37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	182
		GW-46_8-20-1999	8/20/1999	--	--	2.5	--	--	27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150
		GW-46_11-11-1999	11/11/1999	--	--	2.5	--	--	38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	159
		GW-46_2-4-2000	2/4/2000	--	--	2.5	--	--	33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	149
		GW-46_5-9-2000	5/9/2000	--	--	2.5	--	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150
		GW-46_8-7-2000	8/7/2000	--	--	2.5	--	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	146
		GW-46_11-9-2000	11/9/2000	--	--	2.5	--	--	28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	200
		GW-46_2-12-2001	2/12/2001	--	--	2.5	--	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	176
		GW-46_5-23-2001	5/23/2001	--	--	2.5	--	--	28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	171
		KP-GW-46-111904	11/19/04	50	1	0.5	77	0.5	24	190,000	5	5	5	50	1.5	29,000	5	0.1	20	6,400	7.5	5	240,000	0.5	5	180
	PS-18	KP-PS-18-091905	9/19/05	160	1	0.5	170	0.5	2.3	110,000	5	5	5	240	1.5	25,000	2900	0.1	20	29,000	7.5	5	180,000	0.5	5	36
	GW-16	GW-16_6-5-86	6/5/1986	--	--	3.5	--	--	39.5	--	--	--	--	--	3.75	--	--	--	--	--	--	--	--	--	--	170
		GW-16_8-14-86	8/14/1986	--	--	2	--	--	30	--	--	--	--	--	27	--	--	--	--	--	--	--	--	--	--	121
		GW-16_6-27-87	6/27/1987	--	--	3	--	--	31	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	125
		GW-16_9-2-87	9/2/1987	--	--	3	--	--	44	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	213
		GW-16_11-20-87	11/20/1987	--	--	3	--	--	32	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	111
		KP-GW-16-111904	11/19/04	50	1	0.5	71	0.5	50	230,000	5	5	5	120	1.5	37,000	330	0.1	20	6,200	7.5	5	260,000	0.5	5	150
	PS-17	*KP-PS-17-091905*	*9/19/05*	*50*	*1*	*0.5*	*130*	*0.5*	*3.3*	*120,000*	*5*	*5*	*5*	*190*	*1.5*	*26,000*	*420*	*0.1*	*20*	*32,000*	*7.5*	*5*	*190,000*	*0.5*	*5*	*62*
	GW-17	GW-17_7-11-86	7/11/1986	--	--	11	--	--	0.5	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	6
		GW-17_8-21-86	8/21/1986	--	--	5	--	--	0.5	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	4
		GW-17_8-30-87	8/30/1987	--	--	3	--	--	6	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	20
		KP-GW-17-111904	11/19/04	50	1	0.5	16	0.5	0.5	110,000	5	5	5	50	1.5	12,000	11	0.1	20	1,500	7.5	5	150,000	0.5	5	10
	GW-15	GW-15_11-13-85	11/13/1985	--	--	25	--	--	68	--	--	--	--	--	22.75	--	--	--	--	--	--	--	--	--	--	96.5
		GW-15_8-25-86	8/25/1986	--	--	2	--	--	60	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	69
		GW-15_3-17-87	3/17/1987	--	--	8	--	--	54	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	130
		GW-15_6-27-87	6/27/1987	--	--	3.2	--	--	64	--	--	--	--	--	3.1666667	--	--	--	--	--	--	--	--	--	--	53
		GW-15_9-2-87	9/2/1987	--	--	3	--	--	73	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	72
		GW-15_11-20-87	11/20/1987	--	--	3	--	--	59	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	60
		GW-15_9-17-1993	9/17/1993	--	--	2.5	--	--	0.5	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	4
		GW-15_11-18-1993	11/18/1993	--	--	2.5	--	--	74	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	71
		GW-15_2-23-1994	2/23/1994	--	--	2.5	--	--	61	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	71

Table 4-5. Comparison of Dissolved Metals in Site Groundwater to MCLs

all concentrations are in ug/L

Site	Location	Sample	Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Maximum Contaminant Level (MCL)				200	6	10	2000	4	5	--	100	--	1300	300	15	--	50	2	--	--	50	100	--	2	--	5000
OFF-SITE	GW-15	GW-15_5-26-1994	5/26/1994	--	--	2.5	--	--	63	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	98
		GW-15_9-8-1994	9/8/1994	--	--	2.5	--	--	61	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	70
		GW-15_11-2-1994	11/2/1994	--	--	2.5	--	--	61	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	98
		GW-15_2-22-1995	2/22/1995	--	--	2.5	--	--	71	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	83
		GW-15_5-23-1995	5/23/1995	--	--	2.5	--	--	2.0	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	241
		GW-15_8-9-1995	8/9/1995	--	--	2.5	--	--	73	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	107
		GW-15_11-8-1995	11/8/1995	--	--	2.5	--	--	94	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	127
		GW-15_3-7-1996	3/7/1996	--	--	2.5	--	--	112	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	150
		GW-15_6-24-1996	6/24/1996	--	--	2.5	--	--	74	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	84
		GW-15_8-28-1996	8/28/1996	--	--	2.5	--	--	83	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	95
		GW-15_11-26-1996	11/26/1996	--	--	2.5	--	--	44	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	96
		GW-15_3-12-1997	3/12/1997	--	--	2.5	--	--	47	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	86
		GW-15_6-24-1997	6/24/1997	--	--	2.5	--	--	119	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	152
		GW-15_9-24-1997	9/24/1997	--	--	2.5	--	--	115	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	127
		GW-15_11-19-1997	11/19/1997	--	--	2.5	--	--	98	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	91
		GW-15_3-3-1998	3/3/1998	--	--	2.5	--	--	98	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	118
		GW-15_6-2-1998	6/2/1998	--	--	2.5	--	--	84	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	93
		GW-15_8-26-1998	8/26/1998	--	--	2.5	--	--	57	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	84
		GW-15_11-20-1998	11/20/1998	--	--	2.5	--	--	65	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	73
		GW-15_2-17-1999	2/17/1999	--	--	2.5	--	--	87	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100
		GW-15_5-19-1999	5/19/1999	--	--	2.5	--	--	67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	70
		GW-15_8-20-1999	8/20/1999	--	--	2.5	--	--	62	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	74
		GW-15_11-11-1999	11/11/1999	--	--	2.5	--	--	66	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	66
		GW-15_2-4-2000	2/4/2000	--	--	2.5	--	--	78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	89
		GW-15_5-9-2000	5/9/2000	--	--	2.5	--	--	87	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	107
		GW-15_8-7-2000	8/7/2000	--	--	2.5	--	--	87	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	101
		GW-15_11-6-2000	11/6/2000	--	--	2.5	--	--	82	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10
		GW-15_2-12-2001	2/12/2001	--	--	2.5	--	--	94	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	98
		GW-15_5-23-2001	5/23/2001	--	--	2.5	--	--	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	105
		KP-GW-15-111904	11/19/04	50	1	0.5	120	0.5	110	200,000	5	5	5	50	1.5	34,000	34	0.1	20	9,200	7.5	5	250,000	0.5	5	130
	PS-16	KP-PS-16-091905	9/19/05	250	1	0.5	140	0.5	4.8	120,000	5	5	5	230	1.5	26,000	210	0.1	20	30,000	7.5	5	190,000	0.5	5	21
	PS-15	KP-PS-15-091905	9/19/05	190	1	0.5	87	0.5	8.3	160,000	5	5	5	850	1.5	32,000	3700	0.1	20	20,000	7.5	5	230,000	0.5	5	54
	PS-14	KP-PS-14-092005	9/20/05	50	1	1	99	0.5	7.7	160,000	5	5	5	100	1.5	33,000	1500	0.1	20	20,000	7.5	5	230,000	0.5	5	22
	BH-12	BH-12_9-17-85	9/17/1985	--	--	10	--	--	0.5	--	--	--	--	--	10	--	--	--	--	--	--	--	--	--	--	5
		BH-12_8-22-86	8/22/1986	--	--	2	--	--	0.5	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	4
		BH-12_8-29-87	8/29/1987	--	--	3	--	--	4	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	14
		BH-12_9-1-87	9/1/1987	--	--	3	--	--	3	--	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	28
		BH-12_11-18-87	11/18/1987	--	--	3.1666667	--	--	4.9666667	--	--	--	--	--	3.1666667	--	--	--	--	--	--	--	--	--	--	9
	PS-13	KP-PS-13-092005	9/20/05	50	1	0.5	120	0.5	0.5	120,000	5	23	5	690	1.5	25,000	780	0.1	20	28,000	7.5	5	170,000	0.5	5	50
	PS-12	KP-PS-12-092005	9/20/05	50	1	0.5	120	0.5	0.5	150,000	5	5	5	200	1.5	31,000	230	0.1	20	25,000	7.5	5	210,000	0.5	5	21
	PS-11	KP-PS-11-092005	9/20/05	500	1	0.5	130	0.5	0.5	170,000	5	12	5	850	1.5	34,000	360	0.1	20	21,000	7.5	5	250,000	0.5	5	27

shading indicates a concentration that exceeds the federal MCL

MCL = Primary MCL (legally enforceable) Secondary MCL used when primary MCL not available (aluminum, iron, manganese, silver, and zinc).

-- = data not available

non-detects adjusted to 1/2 the detection limit

Table 4-6. Comparison of Total Metals in Site Groundwater to MCLs

all concentrations are in ug/L

Site	Station	Sample	Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Maximum Contaminant Level (MCL)				200	6	10	2,000	4	5	–	100	–	1,300	300	15	–	50	2	–	–	50	100	–	2	–	5000
ON-SITE	SB-04	01-VBOU3-GW-0003	12/18/2003	27,200	2	*2.2	414	1	903	360,120	2	31.6	153	25,700	42.6	53,000	5,690	0.03	56.2	11,200	11	2.19	900,000	4.66	47.4	11,200
	SB-07	01-VBOU3-GW-0002	12/12/2003	355,000	40.1	11,600	1,410	26.1	7400	736,800	460	199	37,500	1,100,000	16,800	148,000	22,800	17.7	889	92,200	39.4	219	833,000	300	541	85,200
	MW-32	MW-32-070104	7/1/2004	440	1	2.3	48	0.5	0.5	230,000	5	5	17	320	1.5	29,000	79	0.1	20	1,500	7.5	5	840,000	0.5	5	10
		MW-32-072804	7/28/2004	170	1	2.7	44	0.5	13	140,000	5	19	5	3,000	1.5	18,000	650	0.1	20	1,500	7.5	5	440,000	0.5	5	10
	MW-33	MW-33-050304	5/3/2004	16,000	1	7.1	220	1.6	67	77,000	26	64	90	28,000	26	11,000	1,300	0.1	46	6,500	7.5	5	100,000	0.5	38	940
		MW-33-052104	5/21/2004	680	1	1.9	29	0.5	27	66,000	5	5	5	560	1.5	6,700	51	0.1	20	1,500	7.5	5	82,000	0.5	5	190
		MW-33-070104	7/1/2004	420	1	3.1	30	0.5	27	75,000	5	5	5	330	1.5	7,300	32	0.1	20	1,500	7.5	5	93,000	0.5	5	220
		MW-33-072804	7/28/2004	110	1	2.2	34	0.5	33	100,000	5	5	5	170	1.5	9,800	23	0.1	20	1,500	7.5	5	120,000	0.5	5	250
	MW-34	MW-34-052104	5/21/2004	260	1	0.5	65	0.5	7.5	610,000	5	5	14	1,100	1.5	54,000	840	0.1	20	13,000	7.5	5	670,000	0.5	5	65
		MW-34-070104	7/1/2004	50	1	0.5	83	0.5	3.5	670,000	5	5	5	160	1.5	75,000	140	0.1	20	11,000	7.5	5	720,000	0.5	5	78
		MW-34-072804	7/28/2004	390	1	1.3	38	0.5	17	300,000	5	5	5	700	1.5	36,000	45	0.1	20	6,600	7.5	5	470,000	0.5	5	10
	MW-35 [1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	MW-36	MW-36-052104	5/21/2004	1,300	1	10	100	0.5	41	480,000	5	5	46	1,600	7.2	60,000	1,600	0.1	20	11,000	7.5	5	430,000	0.5	5	200
OFF-SITE	PS-1	PS-1-050205	5/2/2005	109,000	1	26	1400	4.4	1.8	100,000	150	50	98	170,000	110	33,000	5,800	0.1	70	19,000	7.5	5	300,000	1.2	220	420
	PS-3	PS-3-050205	5/2/2005	360,000	1	60	3200	29	5	340,000	930	180	710	810,000	630	120,000	12,000	1.3	330	63,000	21	5	270,000	3.5	1000	1600
	PS-4	PS-4-050205	5/2/2005	10,000	1	4.3	210	1.2	0.5	200,000	15	5	12	17,000	10	39,000	290	0.1	20	11,000	7.5	5	250,000	0.5	50	41
	PS-7	PS-7-050205	5/2/2005	110,000	1	47	1400	7.8	150	630,000	100	67	240	130,000	120	99,000	2,000	0.1	69	25,000	43	5	610,000	1.6	230	4800
	PS-6	PS-6-050205	5/2/2005	7,700	1	2.8	180	0.5	68	250,000	12	5	5	10,000	7.2	41,000	510	0.1	20	10,000	7.5	5	390,000	0.5	15	330
	PS-5	PS-5-050205	5/2/2005	44,000	1	15	670	4.4	35	240,000	150	43	70	94,000	64	48,000	1,100	0.1	56	18,000	7.5	5	330,000	0.5	140	2100
	PS-19	KP-PS-19-091905	9/19/2005	140,000	1	22	1400	10	2.8	130,000	150	50	220	180,000	160	50,000	5,200	0.25	99	47,000	7.5	5	160,000	1.5	280	720
	GW-46	KP-GW-46-111904	11/19/2004	50	1	0.5	80	0.5	24	200,000	5	5	5	50	1.5	30,000	11	0.1	20	6,700	7.5	5	250,000	0.5	5	170
	PS-18	KP-PS-18-091905	9/19/2005	33000	1	11	670	2.4	14	110,000	60	27	69	49000	54	29,000	6800	0.1	47	34,000	7.5	5	170,000	0.5	79	470
	GW-16	GW-16_6-27-87	6/27/1987	–	–	3	–	–	31	–	–	–	–	–	2.5	–	–	–	–	–	–	–	–	–	–	132
		KP-GW-16-111904	11/19/2004	220	1	0.5	74	0.5	53	230,000	5	5	5	240	1.5	36,000	490	0.1	20	7,800	7.5	5	250,000	0.5	5	150
	PS-17	KP-PS-17-091905	9/19/2005	26000	1	10	590	2	8.4	110,000	43	15	75	35000	61	30,000	780	0.1	20	36,000	7.5	5	170,000	0.5	57	390
	GW-17	KP-GW-17-111904	11/19/2004	3,500	1	3.3	200	0.5	8	120,000	5	11	30	11,000	12	14,000	18,000	0.22	42	3,200	7.5	5	170,000	0.5	12	61
	GW-15	GW-15_11-13-85	11/13/1935	–	–	50	–	–	64.5	–	–	–	–	–	12.5	–	–	–	–	–	–	–	–	–	–	–	99
		GW-15_3-19-86	3/19/1986	–	–		–	–	77	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	170
		GW-15_5-6-86	5/6/1936	–	–	–	–	–	61	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
		GW-15_7-2-86	7/2/1986	–	–	15	–	–	114.7	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–	–	–	264
		GW-15_9-2-86	9/2/1986	–	–	25	–	–	141	–	–	–	–	–	25	–	–	–	–	–	–	–	–	–	–	–	375
		GW-15_11-6-86	11/6/1986	–	–	28.5	–	–	160.5	–	–	–	–	–	40.5	–	–	–	–	–	–	–	–	–	–	–	376.5
		GW-15_1-13-87	1/13/1987	–	–	21	–	–	87	–	–	–	–	–	13	–	–	–	–	–	–	–	–	–	–	–	150
		GW-15_3-17-87	3/17/1987	–	–	90	–	–	320	–	–	–	–	–	190	–	–	–	–	–	–	–	–	–	–	–	1,500
		GW-15_6-27-87	6/27/1987	–	–	15.7	–	–	101	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	317
		GW-15_9-2-87	9/2/1987	–	–	3	–	–	79	–	–	–	–	–	17	–	–	–	–	–	–	–	–	–	–	–	184
		KP-GW-15-111904	11/19/2004	50	1	0.5	120	0.5	110	210,000	5	5	5	100	1.5	35,000	40	0.1	20	9,100	7.5	5	250,000	0.5	5	120
	PS-16	KP-PS-16-091905	9/19/2005	4800	1	0.5	160	0.5	5.6	110,000	5	5	5	4300	3.4	26,000	260	0.1	20	31,000	7.5	5	160,000	0.5	10	37
	PS-15	KP-PS-15-091905	9/19/2005	87000	1	15	1100	5.7	25	160,000	220	40	170	120000	130	46,000	4900	0.1	84	37,000	7.5	5	220,000	1.2	170	940
	PS-14	KP-PS-14-092005	9/20/2005	7700	1	2.2	170	0.5	9.3	150,000	5	5	14	6100	12	32,000	1500	0.1	20	21,000	7.5	5	210,000	0.5	18	60
	BH-12	BH-12_6-29-87	6/29/1987	–	–	9	–	–	4	–	–	–	–	–	61	–	–	–	–	–	–	–	–	–	–	–	184
	PS-13	KP-PS-13-092005	9/20/2005	12000	1	6.2	220	0.5	1.4	120,000	16	25	21	15000	21	27,000	680	0.1	20	30,000	7.5	5	160,000	0.5	28	130
	PS-12	KP-PS-12-092005	9/20/2005	17000	1	3.9	310	1.1	1.2	130,000	22	5	28	19000	25	32,000	360	0.1	20	27,000	7.5	5	190,000	0.5	34	130
	PS-11	KP-PS-11-092005	9/20/2005	8200	1	2.8	230	0.5	0.5	160,000	12	13	16	12000	19	35000	440	0.1	20	22,000	7.5	5	240,000	0.5	16	90

shading indicates a concentration that exceeds the federal MCL
MCL = Primary MCL (legally enforceable). Secondary MCL used when primary MCL not available (aluminum, iron, manganese, silver, and zinc).
– = Data not available
[1] Total metals sample not collected at MW-35. Due to poor recovery, only a dissolved sample was collected.
non-detects adjusted to 1/2 the detection limit

Table 5-1. Summary Statistics for Surface Soil Samples Collected South and Northeast of VBI70 OU3

Surface Soil South of the VBI70 OU3 Site [1]

Chemcial	Samples (N)	Soil Concentration (mg/kg)		Background (mg/kg) [3]	Samples > Background	RBC (mg/kg)		Samples > RBC	
		Average	Maximum			Residential	Commercial	Residential	Commercial
Arsenic [4]	39	25	216	13	27 (69%)	43	191	5 (13%)	1 (3%)
Lead [5]	39	290	782	168	33 (85%)	400	750	6 (15%)	1 (3%)
Cadmium [6]	39	50	145	7	18 (46%)	274	1,022	0 (0%)	0 (0%)
Zinc [6]	39	136	987	497	1 (3%)	987	82,200	0 (0%)	0 (0%)

Surface Soil Northeast of the VBI70 OU3 Site [2]

Chemcial	Samples (N)	Soil Concentration (mg/kg)		Background (mg/kg) [3]	Samples > Background	RBC (mg/kg)		Samples > RBC	
		Average	Maximum			Residential	Commercial	Residential	Commercial
Arsenic [4]	23	19	50	13	15 (65%)	43	191	1 (4%)	0 (0%)
Lead [5]	23	281	650	168	14 (61%)	400	750	4 (17%)	0 (0%)
Cadmium [6]	23	18	60	7	15 (65%)	274	1,022	0 (0%)	0 (0%)
Zinc [6]	23	342	800	497	3 (13%)	987	82,200	0 (0%)	0 (0%)

[1] Summary statistics are based on the average of all grab samples collected at a residential property at VBI70 OU1 (USEPA 2001).

[2] Summary statistics are based on individual grab samples (0-5 inches) collected at a sampling station during the ASARCO Globe Plant RI (TRC 1988).

[3] High end background concentration of metal in regional soil (see Section 4.1.2 and Table 4-1).

[4] RBC based on target cancer risk of 1E-04.

[5] USEPA Region IX Screening Level for Industrial Soil (750 mg/kg) or USEPA default for residential soils (400 mg/kg).

[6] RBC based on target noncancer risk Hazard Quotient (HQ) = 1.

Table 6-1. Summary of Quantitative Chemicals of Potential Concern (COPCs) for Human Receptors

Chemical	COPCs	
	Soil	Groundwater
Aluminum		X
Antimony	X	X
Arsenic	X	X
Barium		X
Beryllium		X
Cadmium	X	X
Calcium		
Chromium		X
Cobalt		X
Copper		X
Iron	X	X
Lead	X	X
Magnesium		
Manganese		X
Mercury		X
Nickel		X
Potassium		
Selenium		X
Silver		X
Sodium		
Thallium	X	X
Vanadium		X
Zinc		X

Table 6-2. Estimated Risks to Commercial Workers from the Incidental Ingestion of Soil

Station	Sample ID	Depth (ft bgs)		NON-CANCER HI		CANCER RISK	
		Top	Bottom	CTE	RME	CTE	RME
01	01-VBOU3-SB-0001-B	0.33	0.83	4E-02	8E-02	2E-07	2E-06
	01-VBOU3-SB-0001-C	1.50	3.00	5E-02	1E-01	2E-07	2E-06
	01-VBOU3-SB-0001-D	5.83	6.92	4E-02	8E-02	2E-08	3E-07
02	01-VBOU3-SB-0002-A	0.33	2.50	4E-02	8E-02	3E-07	3E-06
	01-VBOU3-SB-0002-B	4.00	5.00	4E-02	8E-02	2E-07	2E-06
	01-VBOU3-SB-0002-C	8.50	10.00	4E-02	8E-02	5E-08	6E-07
	01-VBOU3-SB-0002-D	12.00	13.00	6E-02	1E-01	3E-07	4E-06
03	01-VBOU3-SB-0003-A	0.17	2.00	5E-02	1E-01	6E-07	6E-06
	01-VBOU3-SB-0003-B	2.00	3.50	3E-02	7E-02	7E-08	7E-07
	01-VBOU3-SB-0003-C	5.00	6.17	4E-02	9E-02	3E-07	3E-06
	01-VBOU3-SB-0003-D	10.50	11.00	5E-02	1E-01	4E-07	5E-06
04	01-VBOU3-SB-0004-A	0.08	3.00	5E-02	1E-01	9E-07	9E-06
	01-VBOU3-SB-0004-B	6.00	10.00	3E-02	7E-02	1E-07	1E-06
	01-VBOU3-SB-0004-C	10.00	12.50	1E-01	2E-01	3E-07	3E-06
	01-VBOU3-SB-0004-D	15.50	17.00	5E-02	1E-01	1E-07	1E-06
05	01-VBOU3-SB-0005-A	0.00	0.50	6E-02	1E-01	1E-06	1E-05
	01-VBOU3-SB-0005-B	0.83	2.50	4E-02	8E-02	3E-07	3E-06
	01-VBOU3-SB-0005-C	6.50	7.50	4E-02	9E-02	2E-07	2E-06
06	01-VBOU3-SB-0006-A	1.00	4.50	5E-02	1E-01	5E-07	6E-06
	01-VBOU3-SB-0006-B	5.00	6.50	1E-01	3E-01	1E-06	2E-05
	01-VBOU3-SB-0006-C	7.00	10.00	6E-02	1E-01	2E-07	2E-06
07	01-VBOU3-SB-0007-A	0.33	5.00	2E-02	5E-02	5E-08	6E-07
	01-VBOU3-SB-0007-B	5.00	10.00	3E-01	6E-01	1E-06	1E-05
	01-VBOU3-SB-0007-C	10.50	12.00	5E+00	1E+01	1E-04	2E-03
	01-VBOU3-SB-0007-D	14.00	15.00	3E-01	6E-01	5E-07	6E-06
	01-VBOU3-SB-0007-E	20.67	22.00	4E-02	9E-02	2E-07	2E-06
08	01-VBOU3-SB-0008-A	0.25	2.00	5E-02	1E-01	5E-07	5E-06
	01-VBOU3-SB-0008-B	4.00	6.00	5E-02	1E-01	8E-07	9E-06
	01-VBOU3-SB-0008-C	7.00	9.50	4E-02	8E-02	6E-08	7E-07
	01-VBOU3-SB-0008-D	24.00	25.00	4E-02	8E-02	2E-08	3E-07
09	01-VBOU3-SB-0009-A	0.25	2.00	4E-02	9E-02	5E-07	5E-06
	01-VBOU3-SB-0009-B	5.50	7.00	4E-02	9E-02	4E-07	5E-06
	01-VBOU3-SB-0009-C	8.50	9.50	4E-02	9E-02	1E-07	1E-06
	01-VBOU3-SB-0009-D	23.00	24.00	4E-02	1E-01	3E-07	3E-06
10	01-VBOU3-SB-0010-A	0.50	1.50	8E-02	2E-01	4E-07	4E-06
	01-VBOU3-SB-0010-B	2.00	2.83	3E-02	7E-02	1E-07	1E-06
	01-VBOU3-SB-0010-C	5.00	5.92	5E-02	1E-01	4E-07	5E-06
	01-VBOU3-SB-0010-D	8.00	9.00	5E-02	1E-01	6E-08	7E-07
12	01-VBOU3-SB-0012-A	0.25	0.75	5E-02	1E-01	4E-07	5E-06
	01-VBOU3-SB-0012-B	2.00	3.00	4E-02	1E-01	2E-07	2E-06
13	01-VBOU3-SB-0013-A	0.00	0.75	4E-02	9E-02	3E-07	3E-06
	01-VBOU3-SB-0013-B	4.50	5.00	4E-02	8E-02	9E-08	1E-06

Table 6-2. Estimated Risks to Commercial Workers from the Incidental Ingestion of Soil (Continued)

Station	Sample ID	Depth (ft bgs)		NON-CANCER HI		CANCER RISK	
		Top	Bottom	CTE	RME	CTE	RME
14	01-VBOU3-SB-0014-A	3.00	5.00	3E-02	7E-02	1E-07	1E-06
	01-VBOU3-SB-0014-B	8.08	9.25	5E-02	1E-01	1E-07	1E-06
	01-VBOU3-SB-0014-C	19.00	20.00	5E-02	1E-01	2E-07	2E-06
15	01-VBOU3-SB-0015-A	0.25	5.00	5E-02	1E-01	2E-07	2E-06
	01-VBOU3-SB-0015-B	5.00	8.00	4E-02	9E-02	1E-07	1E-06
	01-VBOU3-SB-0015-C	11.00	12.00	4E-02	8E-02	2E-08	3E-07
16	01-VBOU3-SB-0016-A	1.00	2.50	1E-02	3E-02	6E-08	6E-07
	01-VBOU3-SB-0016-B	6.50	9.00	7E-02	2E-01	1E-06	1E-05
	01-VBOU3-SB-0016-D	10.00	11.08	4E-02	8E-02	5E-08	6E-07
17	01-VBOU3-SB-0017-A	0.25	3.00	2E-02	3E-02	1E-07	1E-06
	01-VBOU3-SB-0017-B	5.00	6.08	5E-02	1E-01	1E-07	1E-06
	01-VBOU3-SB-0017-C	9.25	10.50	5E-02	1E-01	3E-07	3E-06
	01-VBOU3-SB-0017-D	11.00	12.50	1E-02	3E-02	2E-08	3E-07
18	01-VBOU3-SB-0018-A	2.00	5.00	3E-02	6E-02	1E-07	1E-06
	01-VBOU3-SB-0018-B	5.00	6.00	6E-02	1E-01	2E-07	2E-06
	01-VBOU3-SB-0018-C	6.00	8.00	6E-02	1E-01	1E-07	2E-06
19	01-VBOU3-SB-0019-A	8.00	9.08	4E-02	8E-02	6E-08	6E-07
	01-VBOU3-SB-0019-B	11.00	11.83	3E-02	6E-02	5E-08	6E-07
20	01-VBOU3-SB-0020-A	2.00	3.00	5E-02	1E-01	8E-08	8E-07
	01-VBOU3-SB-0020-B	8.75	10.00	1E-01	2E-01	1E-06	1E-05
21	01-VBOU3-SB-0021-A	0.50	2.00	7E-02	1E-01	1E-06	1E-05
	01-VBOU3-SB-0021-B	4.50	5.50	3E-02	7E-02	9E-08	1E-06
	01-VBOU3-SB-0021-C	8.00	9.00	3E-02	7E-02	2E-08	3E-07
22	01-VBOU3-SB-0022-A	2.00	4.00	1E-01	2E-01	3E-06	3E-05
	01-VBOU3-SB-0022-B	6.00	8.50	6E-02	1E-01	7E-07	8E-06
	01-VBOU3-SB-0022-C	10.50	12.00	4E-02	8E-02	7E-08	8E-07
	01-VBOU3-SB-0022-D	21.00	23.00	1E-01	2E-01	2E-06	2E-05
23	01-VBOU3-SB-0023-A	0.08	1.50	4E-02	8E-02	2E-07	2E-06
	01-VBOU3-SB-0023-B	2.00	5.00	4E-02	9E-02	1E-07	2E-06
	01-VBOU3-SB-0023-C	10.00	10.67	5E-02	1E-01	3E-07	3E-06
24	01-VBOU3-SB-0024-A	0.50	3.00	1E-01	3E-01	3E-06	3E-05
	01-VBOU3-SB-0024-D	6.50	7.50	7E-02	1E-01	6E-07	7E-06
25	01-VBOU3-SB-0025-A	0.17	1.50	6E-02	1E-01	9E-08	1E-06
	01-VBOU3-SB-0025-B	5.50	6.00	6E-02	1E-01	1E-07	1E-06
26	01-VBOU3-SB-0026-A	0.25	2.83	3E-02	7E-02	2E-07	2E-06
	01-VBOU3-SB-0026-B	3.00	4.50	5E-02	1E-01	2E-07	2E-06
27	01-VBOU3-SB-0027-A	0.17	3.00	4E-02	9E-02	2E-07	2E-06
	01-VBOU3-SB-0027-B	5.00	9.00	6E-02	1E-01	5E-07	5E-06
	01-VBOU3-SB-0027-C	13.00	14.17	5E-02	1E-01	1E-07	2E-06
	01-VBOU3-SB-0027-D	17.00	18.00	6E-02	1E-01	5E-07	5E-06
	01-VBOU3-SB-0027-E	20.33	21.00	4E-02	8E-02	9E-08	1E-06
28	01-VBOU3-SB-0028-A	0.92	1.92	4E-02	9E-02	1E-07	1E-06
	01-VBOU3-SB-0028-B	10.00	10.50	6E-02	1E-01	2E-07	3E-06
	01-VBOU3-SB-0028-C	14.00	15.00	4E-02	8E-02	3E-07	3E-06
	01-VBOU3-SB-0028-D	19.00	20.00	3E-02	7E-02	9E-08	1E-06
	01-VBOU3-SB-0028-E	24.00	25.50	4E-02	8E-02	1E-07	1E-06

Table 6-2. Estimated Risks to Commercial Workers from the Incidental Ingestion of Soil (Continued)

Station	Sample ID	Depth (ft bgs)		NON-CANCER HI		CANCER RISK	
		Top	Bottom	CTE	RME	CTE	RME
29	01-VBOU3-SB-0029-A	1.83	2.83	5E-02	1E-01	2E-08	3E-07
	01-VBOU3-SB-0029-B	5.00	5.50	4E-02	9E-02	2E-08	3E-07
	01-VBOU3-SB-0029-C	11.00	11.92	4E-02	8E-02	2E-08	3E-07
	01-VBOU3-SB-0029-D	15.50	16.33	4E-02	8E-02	5E-08	6E-07
	01-VBOU3-SB-0029-E	20.00	21.00	4E-02	8E-02	7E-08	8E-07
30	01-VBOU3-SB-0030-A	0.00	0.50	4E-02	8E-02	1E-07	1E-06
	01-VBOU3-SB-0030-B	1.00	3.00	4E-02	9E-02	6E-08	7E-07
	01-VBOU3-SB-0030-C	9.00	10.50	2E-02	5E-02	2E-07	2E-06
31	01-VBOU3-SB-0031-A	0.83	2.00	4E-02	1E-01	6E-08	6E-07
	01-VBOU3-SB-0031-B	5.00	6.17	4E-02	8E-02	2E-08	3E-07
	01-VBOU3-SB-0031-C	10.00	11.00	5E-02	1E-01	2E-08	3E-07
32	01-VBOU3-SB-0032-A	0.33	2.50	5E-02	1E-01	6E-07	7E-06
	01-VBOU3-SB-0032-B	6.00	8.50	7E-02	1E-01	4E-07	4E-06
	01-VBOU3-SB-0032-C	9.00	10.50	4E-02	8E-02	5E-08	5E-07
	01-VBOU3-SB-0032-D	13.83	15.00	5E-02	1E-01	2E-08	3E-07
	01-VBOU3-SB-0032-E	24.00	25.00	4E-02	9E-02	2E-07	2E-06
33	01-VBOU3-SB-0033-A	0.33	2.50	4E-02	8E-02	3E-07	3E-06
	01-VBOU3-SB-0033-B	3.00	4.00	4E-02	8E-02	1E-07	2E-06
	01-VBOU3-SB-0033-C	9.00	10.00	3E-02	5E-02	9E-08	9E-07
	01-VBOU3-SB-0033-D	15.67	16.50	1E-02	2E-02	2E-08	3E-07
	01-VBOU3-SB-0033-E	18.00	18.50	4E-02	9E-02	3E-07	4E-06
34	01-VBOU3-SB-0034-A	0.33	2.33	5E-02	1E-01	4E-07	5E-06
	01-VBOU3-SB-0034-B	4.50	6.50	5E-02	1E-01	5E-07	5E-06
	01-VBOU3-SB-0034-C	11.00	13.00	3E-02	7E-02	1E-07	1E-06
	01-VBOU3-SB-0034-E	18.00	19.50	2E-02	4E-02	6E-08	6E-07
	01-VBOU3-SB-0034-F	21.00	22.00	5E-02	1E-01	2E-07	3E-06
35	01-VBOU3-SB-0035-A	0.50	3.50	3E-02	5E-02	1E-07	1E-06
	01-VBOU3-SB-0035-B	9.00	9.67	1E-02	3E-02	5E-08	5E-07
	01-VBOU3-SB-0035-C	9.83	10.83	3E-02	6E-02	6E-08	7E-07
36	01-VBOU3-SB-0036-A	0.25	3.50	4E-02	8E-02	3E-07	3E-06
	01-VBOU3-SB-0036-B	5.00	10.00	3E-02	7E-02	1E-07	1E-06
	01-VBOU3-SB-0036-C	11.00	12.00	3E-02	7E-02	6E-08	6E-07
37	01-VBOU3-SB-0037-A	0.00	1.00	4E-02	9E-02	3E-07	3E-06
	01-VBOU3-SB-0037-B	5.83	7.00	4E-02	8E-02	1E-07	1E-06
	01-VBOU3-SB-0037-C	10.00	11.17	3E-02	7E-02	1E-07	2E-06

Shading indicates non-cancer HI that exceeds 1E+00 or cancer risk that exceeds 1E-04

CTE = Central Tendency Exposure

ft bgs = feet below ground surface

HI = Hazard Index

RME = Reasonable Maximum Exposure

Table 6-3. Predicted Blood Lead Levels for Commercial Workers Exposed to Lead in Soil

Station	Sample	Depth (ft bgs)		Lead Concentration (mg/kg)	Predicted PbB (ug/dL)		P10 (fetal)
		Top	Bottom		PbB (GM, adult)	PbB (GM, fetal)	
01	01-VBOU3-SB-0001-B	0.33	0.83	11	1.37	1.23	0.25%
	01-VBOU3-SB-0001-C	1.50	3.00	16	1.37	1.24	0.25%
	01-VBOU3-SB-0001-D	5.83	6.92	18	1.37	1.24	0.26%
02	01-VBOU3-SB-0002-A	0.33	2.50	8.9	1.37	1.23	0.25%
	01-VBOU3-SB-0002-B	4.00	5.00	9	1.37	1.23	0.25%
	01-VBOU3-SB-0002-C	8.50	10.00	30	1.38	1.24	0.26%
	01-VBOU3-SB-0002-D	12.00	13.00	7.1	1.37	1.23	0.25%
03	01-VBOU3-SB-0003-A	0.17	2.00	270	1.57	1.41	0.44%
	01-VBOU3-SB-0003-B	2.00	3.50	11	1.37	1.23	0.25%
	01-VBOU3-SB-0003-C	5.00	6.17	10	1.37	1.23	0.25%
	01-VBOU3-SB-0003-D	10.50	11.00	13	1.37	1.23	0.25%
04	01-VBOU3-SB-0004-A	0.08	3.00	190	1.51	1.36	0.37%
	01-VBOU3-SB-0004-B	6.00	10.00	11	1.37	1.23	0.25%
	01-VBOU3-SB-0004-C	10.00	12.50	9.4	1.37	1.23	0.25%
	01-VBOU3-SB-0004-D	15.50	17.00	8.5	1.37	1.23	0.25%
05	01-VBOU3-SB-0005-A	0.00	0.50	160	1.48	1.33	0.35%
	01-VBOU3-SB-0005-B	0.83	2.50	6.4	1.36	1.23	0.25%
	01-VBOU3-SB-0005-C	6.50	7.50	11	1.37	1.23	0.25%
06	01-VBOU3-SB-0006-A	1.00	4.50	110	1.44	1.30	0.31%
	01-VBOU3-SB-0006-B	5.00	6.50	170	1.49	1.34	0.36%
	01-VBOU3-SB-0006-C	7.00	10.00	18	1.37	1.24	0.26%
07	01-VBOU3-SB-0007-A	0.33	5.00	8.9	1.37	1.23	0.25%
	01-VBOU3-SB-0007-B	5.00	10.00	430	1.69	1.52	0.58%
	01-VBOU3-SB-0007-C	10.50	12.00	1,600	2.59	2.33	2.56%
	01-VBOU3-SB-0007-D	14.00	15.00	32	1.38	1.25	0.26%
	01-VBOU3-SB-0007-E	20.67	22.00	17	1.37	1.24	0.26%
08	01-VBOU3-SB-0008-A	0.25	2.00	400	1.67	1.50	0.55%
	01-VBOU3-SB-0008-B	4.00	6.00	160	1.48	1.33	0.35%
	01-VBOU3-SB-0008-C	7.00	9.50	17	1.37	1.24	0.26%
	01-VBOU3-SB-0008-D	24.00	25.00	40	1.39	1.25	0.27%
09	01-VBOU3-SB-0009-A	0.25	2.00	100	1.44	1.29	0.31%
	01-VBOU3-SB-0009-B	5.50	7.00	11	1.37	1.23	0.25%
	01-VBOU3-SB-0009-C	8.50	9.50	18	1.37	1.24	0.26%
	01-VBOU3-SB-0009-D	23.00	24.00	17	1.37	1.24	0.26%
10	01-VBOU3-SB-0010-A	0.50	1.50	12	1.37	1.23	0.25%
	01-VBOU3-SB-0010-B	2.00	2.83	12	1.37	1.23	0.25%
	01-VBOU3-SB-0010-C	5.00	5.92	12	1.37	1.23	0.25%
	01-VBOU3-SB-0010-D	8.00	9.00	18	1.37	1.24	0.26%
12	01-VBOU3-SB-0012-A	0.25	0.75	360	1.64	1.47	0.52%
	01-VBOU3-SB-0012-B	2.00	3.00	36	1.39	1.25	0.27%
13	01-VBOU3-SB-0013-A	0.00	0.75	130	1.46	1.31	0.33%
	01-VBOU3-SB-0013-B	4.50	5.00	14	1.37	1.23	0.25%

Table 6-3. Predicted Blood Lead Levels for Commercial Workers Exposed to Lead in Soil (Continued)

Station	Sample	Depth (ft bgs)		Lead Concentration (mg/kg)	Predicted PbB (ug/dL)		P10 (fetal)
		Top	Bottom		PbB (GM, adult)	PbB (GM, fetal)	
14	01-VBOU3-SB-0014-A	3.00	5.00	13	1.37	1.23	0.25%
	01-VBOU3-SB-0014-B	8.08	9.25	11	1.37	1.23	0.25%
	01-VBOU3-SB-0014-C	19.00	20.00	12	1.37	1.23	0.25%
15	01-VBOU3-SB-0015-A	0.25	5.00	280	1.58	1.42	0.44%
	01-VBOU3-SB-0015-B	5.00	8.00	24	1.38	1.24	0.26%
	01-VBOU3-SB-0015-C	11.00	12.00	18	1.37	1.24	0.26%
16	01-VBOU3-SB-0016-A	1.00	2.50	5.1	1.36	1.23	0.25%
	01-VBOU3-SB-0016-B	6.50	9.00	10	1.37	1.23	0.25%
	01-VBOU3-SB-0016-D	10.00	11.08	15	1.37	1.23	0.25%
17	01-VBOU3-SB-0017-A	0.25	3.00	43	1.39	1.25	0.27%
	01-VBOU3-SB-0017-B	5.00	6.08	7.2	1.37	1.23	0.25%
	01-VBOU3-SB-0017-C	9.25	10.50	16	1.37	1.24	0.25%
	01-VBOU3-SB-0017-D	11.00	12.50	3.4	1.36	1.23	0.25%
18	01-VBOU3-SB-0018-A	2.00	5.00	44	1.39	1.25	0.27%
	01-VBOU3-SB-0018-B	5.00	6.00	12	1.37	1.23	0.25%
	01-VBOU3-SB-0018-C	6.00	8.00	7.8	1.37	1.23	0.25%
19	01-VBOU3-SB-0019-A	8.00	9.08	11	1.37	1.23	0.25%
	01-VBOU3-SB-0019-B	11.00	11.83	22	1.38	1.24	0.26%
20	01-VBOU3-SB-0020-A	2.00	3.00	7.3	1.37	1.23	0.25%
	01-VBOU3-SB-0020-B	8.75	10.00	18	1.37	1.24	0.26%
21	01-VBOU3-SB-0021-A	0.50	2.00	210	1.52	1.37	0.39%
	01-VBOU3-SB-0021-B	4.50	5.50	15	1.37	1.23	0.25%
	01-VBOU3-SB-0021-C	8.00	9.00	13	1.37	1.23	0.25%
22	01-VBOU3-SB-0022-A	2.00	4.00	380	1.65	1.49	0.54%
	01-VBOU3-SB-0022-B	6.00	8.50	140	1.47	1.32	0.34%
	01-VBOU3-SB-0022-C	10.50	12.00	15	1.37	1.23	0.25%
	01-VBOU3-SB-0022-D	21.00	23.00	16	1.37	1.24	0.25%
23	01-VBOU3-SB-0023-A	0.08	1.50	35	1.39	1.25	0.27%
	01-VBOU3-SB-0023-B	2.00	5.00	21	1.38	1.24	0.26%
	01-VBOU3-SB-0023-C	10.00	10.67	15	1.37	1.23	0.25%
24	01-VBOU3-SB-0024-A	0.50	3.00	10	1.37	1.23	0.25%
	01-VBOU3-SB-0024-D	6.50	7.50	14	1.37	1.23	0.25%
25	01-VBOU3-SB-0025-A	0.17	1.50	7.6	1.37	1.23	0.25%
	01-VBOU3-SB-0025-B	5.50	6.00	6.5	1.37	1.23	0.25%
26	01-VBOU3-SB-0026-A	0.25	2.83	23	1.38	1.24	0.26%
	01-VBOU3-SB-0026-B	3.00	4.50	50	1.40	1.26	0.28%
27	01-VBOU3-SB-0027-A	0.17	3.00	19	1.37	1.24	0.26%
	01-VBOU3-SB-0027-B	5.00	9.00	40	1.39	1.25	0.27%
	01-VBOU3-SB-0027-C	13.00	14.17	9.2	1.37	1.23	0.25%
	01-VBOU3-SB-0027-D	17.00	18.00	11	1.37	1.23	0.25%
	01-VBOU3-SB-0027-E	20.33	21.00	16	1.37	1.24	0.25%

Table 6-3. Predicted Blood Lead Levels for Commercial Workers Exposed to Lead in Soil (Continued)

Station	Sample	Depth (ft bgs)		Lead Concentration (mg/kg)	Predicted PbB (ug/dL)		P10 (fetal)
		Top	Bottom		PbB (GM, adult)	PbB (GM, fetal)	
28	01-VBOU3-SB-0028-A	0.92	1.92	12	1.37	1.23	0.25%
	01-VBOU3-SB-0028-B	10.00	10.50	9.1	1.37	1.23	0.25%
	01-VBOU3-SB-0028-C	14.00	15.00	19	1.37	1.24	0.26%
	01-VBOU3-SB-0028-D	19.00	20.00	16	1.37	1.24	0.25%
	01-VBOU3-SB-0028-E	24.00	25.50	11	1.37	1.23	0.25%
29	01-VBOU3-SB-0029-A	1.83	2.83	15	1.37	1.23	0.25%
	01-VBOU3-SB-0029-B	5.00	5.50	14	1.37	1.23	0.25%
	01-VBOU3-SB-0029-C	11.00	11.92	21	1.38	1.24	0.26%
	01-VBOU3-SB-0029-D	15.50	16.33	13	1.37	1.23	0.25%
	01-VBOU3-SB-0029-E	20.00	21.00	27	1.38	1.24	0.26%
30	01-VBOU3-SB-0030-A	0.00	0.50	22	1.38	1.24	0.26%
	01-VBOU3-SB-0030-B	1.00	3.00	15	1.37	1.23	0.25%
	01-VBOU3-SB-0030-C	9.00	10.50	6.4	1.36	1.23	0.25%
31	01-VBOU3-SB-0031-A	0.83	2.00	17	1.37	1.24	0.26%
	01-VBOU3-SB-0031-B	5.00	6.17	14	1.37	1.23	0.25%
	01-VBOU3-SB-0031-C	10.00	11.00	10	1.37	1.23	0.25%
32	01-VBOU3-SB-0032-A	0.33	2.50	110	1.44	1.30	0.31%
	01-VBOU3-SB-0032-B	6.00	8.50	230	1.54	1.38	0.40%
	01-VBOU3-SB-0032-C	9.00	10.50	21	1.38	1.24	0.26%
	01-VBOU3-SB-0032-D	13.83	15.00	24	1.38	1.24	0.26%
	01-VBOU3-SB-0032-E	24.00	25.00	18	1.37	1.24	0.26%
33	01-VBOU3-SB-0033-A	0.33	2.50	21	1.38	1.24	0.26%
	01-VBOU3-SB-0033-B	3.00	4.00	12	1.37	1.23	0.25%
	01-VBOU3-SB-0033-C	9.00	10.00	9.3	1.37	1.23	0.25%
	01-VBOU3-SB-0033-D	15.67	16.50	0.4	1.36	1.22	0.25%
	01-VBOU3-SB-0033-E	18.00	18.50	18	1.37	1.24	0.26%
34	01-VBOU3-SB-0034-A	0.33	2.33	19	1.37	1.24	0.26%
	01-VBOU3-SB-0034-B	4.50	6.50	12	1.37	1.23	0.25%
	01-VBOU3-SB-0034-C	11.00	13.00	12	1.37	1.23	0.25%
	01-VBOU3-SB-0034-E	18.00	19.50	4.1	1.36	1.23	0.25%
	01-VBOU3-SB-0034-F	21.00	22.00	12	1.37	1.23	0.25%
35	01-VBOU3-SB-0035-A	0.50	3.50	11	1.37	1.23	0.25%
	01-VBOU3-SB-0035-B	9.00	9.67	3.3	1.36	1.23	0.25%
	01-VBOU3-SB-0035-C	9.83	10.83	20	1.38	1.24	0.26%
36	01-VBOU3-SB-0036-A	0.25	3.50	21	1.38	1.24	0.26%
	01-VBOU3-SB-0036-B	5.00	10.00	13	1.37	1.23	0.25%
	01-VBOU3-SB-0036-C	11.00	12.00	19	1.37	1.24	0.26%
37	01-VBOU3-SB-0037-A	0.00	1.00	30	1.38	1.24	0.26%
	01-VBOU3-SB-0037-B	5.83	7.00	16	1.37	1.24	0.25%
	01-VBOU3-SB-0037-C	10.00	11.17	12	1.37	1.23	0.25%

Shading indicates probabilitly of fetal blood lead concentration that exceeds USEPA's recommended level (P10<5%)

ft bgs = feet below ground surface

GM = Geometric mean

P10 = Probability (%) that a blood lead level exceeds 10 ug/dL

Table 6-4. Estimated Risks to Construction Workers from Incidental Ingestion of Soil

Station	Sample ID	Depth (ft bgs)		NON-CANCER HI		CANCER RISK	
		Top	Bottom	CTE	RME	CTE	RME
01	01-VBOU3-SB-0001-B	0.33	0.83	5E-03	2E-02	3E-08	1E-07
	01-VBOU3-SB-0001-C	1.50	3.00	7E-03	3E-02	3E-08	1E-07
	01-VBOU3-SB-0001-D	5.83	6.92	5E-03	2E-02	3E-09	1E-08
02	01-VBOU3-SB-0002-A	0.33	2.50	5E-03	2E-02	4E-08	1E-07
	01-VBOU3-SB-0002-B	4.00	5.00	5E-03	2E-02	3E-08	1E-07
	01-VBOU3-SB-0002-C	8.50	10.00	5E-03	2E-02	8E-09	3E-08
	01-VBOU3-SB-0002-D	12.00	13.00	8E-03	3E-02	5E-08	2E-07
03	01-VBOU3-SB-0003-A	0.17	2.00	8E-03	3E-02	8E-08	3E-07
	01-VBOU3-SB-0003-B	2.00	3.50	5E-03	2E-02	1E-08	4E-08
	01-VBOU3-SB-0003-C	5.00	6.17	6E-03	2E-02	4E-08	2E-07
	01-VBOU3-SB-0003-D	10.50	11.00	7E-03	3E-02	6E-08	2E-07
04	01-VBOU3-SB-0004-A	0.08	3.00	7E-03	3E-02	1E-07	5E-07
	01-VBOU3-SB-0004-B	6.00	10.00	5E-03	2E-02	2E-08	7E-08
	01-VBOU3-SB-0004-C	10.00	12.50	2E-02	6E-02	4E-08	2E-07
	01-VBOU3-SB-0004-D	15.50	17.00	7E-03	3E-02	2E-08	7E-08
05	01-VBOU3-SB-0005-A	0.00	0.50	9E-03	4E-02	2E-07	8E-07
	01-VBOU3-SB-0005-B	0.83	2.50	5E-03	2E-02	4E-08	2E-07
	01-VBOU3-SB-0005-C	6.50	7.50	6E-03	2E-02	3E-08	1E-07
06	01-VBOU3-SB-0006-A	1.00	4.50	8E-03	3E-02	8E-08	3E-07
	01-VBOU3-SB-0006-B	5.00	6.50	2E-02	7E-02	2E-07	8E-07
	01-VBOU3-SB-0006-C	7.00	10.00	8E-03	3E-02	3E-08	1E-07
07	01-VBOU3-SB-0007-A	0.33	5.00	3E-03	1E-02	8E-09	3E-08
	01-VBOU3-SB-0007-B	5.00	10.00	4E-02	1E-01	2E-07	7E-07
	01-VBOU3-SB-0007-C	10.50	12.00	7E-01	3E+00	2E-05	8E-05
	01-VBOU3-SB-0007-D	14.00	15.00	4E-02	2E-01	8E-08	3E-07
	01-VBOU3-SB-0007-E	20.67	22.00	6E-03	2E-02	3E-08	1E-07
08	01-VBOU3-SB-0008-A	0.25	2.00	7E-03	3E-02	7E-08	3E-07
	01-VBOU3-SB-0008-B	4.00	6.00	8E-03	3E-02	1E-07	5E-07
	01-VBOU3-SB-0008-C	7.00	9.50	5E-03	2E-02	9E-09	4E-08
	01-VBOU3-SB-0008-D	24.00	25.00	5E-03	2E-02	3E-09	1E-08
09	01-VBOU3-SB-0009-A	0.25	2.00	6E-03	2E-02	7E-08	3E-07
	01-VBOU3-SB-0009-B	5.50	7.00	6E-03	2E-02	6E-08	3E-07
	01-VBOU3-SB-0009-C	8.50	9.50	6E-03	2E-02	1E-08	6E-08
	01-VBOU3-SB-0009-D	23.00	24.00	6E-03	3E-02	4E-08	2E-07
10	01-VBOU3-SB-0010-A	0.50	1.50	1E-02	4E-02	5E-08	2E-07
	01-VBOU3-SB-0010-B	2.00	2.83	4E-03	2E-02	2E-08	8E-08
	01-VBOU3-SB-0010-C	5.00	5.92	7E-03	3E-02	6E-08	2E-07
	01-VBOU3-SB-0010-D	8.00	9.00	7E-03	3E-02	9E-09	4E-08
12	01-VBOU3-SB-0012-A	0.25	0.75	7E-03	3E-02	6E-08	2E-07
	01-VBOU3-SB-0012-B	2.00	3.00	6E-03	3E-02	3E-08	1E-07
13	01-VBOU3-SB-0013-A	0.00	0.75	6E-03	2E-02	4E-08	1E-07
	01-VBOU3-SB-0013-B	4.50	5.00	5E-03	2E-02	1E-08	5E-08

Table 6-4. Estimated Risks to Construction Workers from Incidental Ingestion of Soil (Continued)

Station	Sample ID	Depth (ft bgs)		NON-CANCER HI		CANCER RISK	
		Top	Bottom	CTE	RME	CTE	RME
14	01-VBOU3-SB-0014-A	3.00	5.00	5E-03	2E-02	1E-08	6E-08
	01-VBOU3-SB-0014-B	8.08	9.25	7E-03	3E-02	2E-08	7E-08
	01-VBOU3-SB-0014-C	19.00	20.00	7E-03	3E-02	2E-08	9E-08
15	01-VBOU3-SB-0015-A	0.25	5.00	7E-03	3E-02	2E-08	1E-07
	01-VBOU3-SB-0015-B	5.00	8.00	6E-03	2E-02	2E-08	7E-08
	01-VBOU3-SB-0015-C	11.00	12.00	5E-03	2E-02	3E-09	1E-08
16	01-VBOU3-SB-0016-A	1.00	2.50	2E-03	7E-03	8E-09	3E-08
	01-VBOU3-SB-0016-B	6.50	9.00	1E-02	4E-02	2E-07	6E-07
	01-VBOU3-SB-0016-D	10.00	11.08	5E-03	2E-02	8E-09	3E-08
17	01-VBOU3-SB-0017-A	0.25	3.00	2E-03	9E-03	2E-08	7E-08
	01-VBOU3-SB-0017-B	5.00	6.08	7E-03	3E-02	1E-08	6E-08
	01-VBOU3-SB-0017-C	9.25	10.50	7E-03	3E-02	4E-08	2E-07
	01-VBOU3-SB-0017-D	11.00	12.50	2E-03	8E-03	3E-09	1E-08
18	01-VBOU3-SB-0018-A	2.00	5.00	4E-03	2E-02	2E-08	7E-08
	01-VBOU3-SB-0018-B	5.00	6.00	8E-03	3E-02	2E-08	1E-07
	01-VBOU3-SB-0018-C	6.00	8.00	8E-03	3E-02	2E-08	8E-08
19	01-VBOU3-SB-0019-A	8.00	9.08	5E-03	2E-02	8E-09	3E-08
	01-VBOU3-SB-0019-B	11.00	11.83	4E-03	2E-02	8E-09	3E-08
20	01-VBOU3-SB-0020-A	2.00	3.00	7E-03	3E-02	1E-08	4E-08
	01-VBOU3-SB-0020-B	8.75	10.00	2E-02	6E-02	2E-07	7E-07
21	01-VBOU3-SB-0021-A	0.50	2.00	9E-03	4E-02	2E-07	6E-07
	01-VBOU3-SB-0021-B	4.50	5.50	5E-03	2E-02	1E-08	5E-08
	01-VBOU3-SB-0021-C	8.00	9.00	5E-03	2E-02	3E-09	1E-08
22	01-VBOU3-SB-0022-A	2.00	4.00	1E-02	6E-02	4E-07	1E-06
	01-VBOU3-SB-0022-B	6.00	8.50	8E-03	3E-02	1E-07	4E-07
	01-VBOU3-SB-0022-C	10.50	12.00	5E-03	2E-02	1E-08	4E-08
	01-VBOU3-SB-0022-D	21.00	23.00	2E-02	6E-02	3E-07	1E-06
23	01-VBOU3-SB-0023-A	0.08	1.50	5E-03	2E-02	2E-08	1E-07
	01-VBOU3-SB-0023-B	2.00	5.00	6E-03	2E-02	2E-08	8E-08
	01-VBOU3-SB-0023-C	10.00	10.67	6E-03	3E-02	4E-08	2E-07
24	01-VBOU3-SB-0024-A	0.50	3.00	2E-02	7E-02	4E-07	1E-06
	01-VBOU3-SB-0024-D	6.50	7.50	9E-03	4E-02	9E-08	4E-07
25	01-VBOU3-SB-0025-A	0.17	1.50	8E-03	3E-02	1E-08	5E-08
	01-VBOU3-SB-0025-B	5.50	6.00	8E-03	3E-02	1E-08	6E-08
26	01-VBOU3-SB-0026-A	0.25	2.83	4E-03	2E-02	2E-08	9E-08
	01-VBOU3-SB-0026-B	3.00	4.50	7E-03	3E-02	3E-08	1E-07
27	01-VBOU3-SB-0027-A	0.17	3.00	6E-03	2E-02	3E-08	1E-07
	01-VBOU3-SB-0027-B	5.00	9.00	9E-03	3E-02	7E-08	3E-07
	01-VBOU3-SB-0027-C	13.00	14.17	8E-03	3E-02	2E-08	8E-08
	01-VBOU3-SB-0027-D	17.00	18.00	9E-03	3E-02	7E-08	3E-07
	01-VBOU3-SB-0027-E	20.33	21.00	6E-03	2E-02	1E-08	5E-08
28	01-VBOU3-SB-0028-A	0.92	1.92	6E-03	2E-02	2E-08	7E-08
	01-VBOU3-SB-0028-B	10.00	10.50	9E-03	4E-02	3E-08	1E-07
	01-VBOU3-SB-0028-C	14.00	15.00	5E-03	2E-02	4E-08	1E-07
	01-VBOU3-SB-0028-D	19.00	20.00	5E-03	2E-02	1E-08	5E-08
	01-VBOU3-SB-0028-E	24.00	25.50	5E-03	2E-02	2E-08	6E-08

Table 6-4. Estimated Risks to Construction Workers from Incidental Ingestion of Soil (Continued)

Station	Sample ID	Depth (ft bgs)		NON-CANCER HI		CANCER RISK	
		Top	Bottom	CTE	RME	CTE	RME
29	01-VBOU3-SB-0029-A	1.83	2.83	7E-03	3E-02	3E-09	1E-08
	01-VBOU3-SB-0029-B	5.00	5.50	6E-03	2E-02	3E-09	1E-08
	01-VBOU3-SB-0029-C	11.00	11.92	5E-03	2E-02	3E-09	1E-08
	01-VBOU3-SB-0029-D	15.50	16.33	5E-03	2E-02	8E-09	3E-08
	01-VBOU3-SB-0029-E	20.00	21.00	5E-03	2E-02	1E-08	4E-08
30	01-VBOU3-SB-0030-A	0.00	0.50	5E-03	2E-02	2E-08	8E-08
	01-VBOU3-SB-0030-B	1.00	3.00	6E-03	2E-02	9E-09	4E-08
	01-VBOU3-SB-0030-C	9.00	10.50	3E-03	1E-02	2E-08	9E-08
31	01-VBOU3-SB-0031-A	0.83	2.00	6E-03	3E-02	8E-09	3E-08
	01-VBOU3-SB-0031-B	5.00	6.17	5E-03	2E-02	3E-09	1E-08
	01-VBOU3-SB-0031-C	10.00	11.00	6E-03	3E-02	3E-09	1E-08
32	01-VBOU3-SB-0032-A	0.33	2.50	8E-03	3E-02	9E-08	4E-07
	01-VBOU3-SB-0032-B	6.00	8.50	9E-03	4E-02	5E-08	2E-07
	01-VBOU3-SB-0032-C	9.00	10.50	6E-03	2E-02	7E-09	3E-08
	01-VBOU3-SB-0032-D	13.83	15.00	8E-03	3E-02	3E-09	1E-08
	01-VBOU3-SB-0032-E	24.00	25.00	6E-03	2E-02	2E-08	1E-07
33	01-VBOU3-SB-0033-A	0.33	2.50	5E-03	2E-02	4E-08	2E-07
	01-VBOU3-SB-0033-B	3.00	4.00	5E-03	2E-02	2E-08	8E-08
	01-VBOU3-SB-0033-C	9.00	10.00	4E-03	1E-02	1E-08	5E-08
	01-VBOU3-SB-0033-D	15.67	16.50	2E-03	6E-03	3E-09	1E-08
	01-VBOU3-SB-0033-E	18.00	18.50	6E-03	2E-02	5E-08	2E-07
34	01-VBOU3-SB-0034-A	0.33	2.33	7E-03	3E-02	6E-08	2E-07
	01-VBOU3-SB-0034-B	4.50	6.50	7E-03	3E-02	6E-08	3E-07
	01-VBOU3-SB-0034-C	11.00	13.00	5E-03	2E-02	2E-08	7E-08
	01-VBOU3-SB-0034-E	18.00	19.50	3E-03	1E-02	8E-09	3E-08
	01-VBOU3-SB-0034-F	21.00	22.00	7E-03	3E-02	3E-08	1E-07
35	01-VBOU3-SB-0035-A	0.50	3.50	4E-03	1E-02	2E-08	7E-08
	01-VBOU3-SB-0035-B	9.00	9.67	2E-03	8E-03	7E-09	3E-08
	01-VBOU3-SB-0035-C	9.83	10.83	4E-03	1E-02	9E-09	4E-08
36	01-VBOU3-SB-0036-A	0.25	3.50	5E-03	2E-02	4E-08	2E-07
	01-VBOU3-SB-0036-B	5.00	10.00	5E-03	2E-02	2E-08	7E-08
	01-VBOU3-SB-0036-C	11.00	12.00	5E-03	2E-02	8E-09	3E-08
37	01-VBOU3-SB-0037-A	0.00	1.00	6E-03	2E-02	4E-08	2E-07
	01-VBOU3-SB-0037-B	5.83	7.00	5E-03	2E-02	2E-08	7E-08
	01-VBOU3-SB-0037-C	10.00	11.17	5E-03	2E-02	2E-08	8E-08

Shading indicates non-cancer risk that exceeds 1E+00 or cancer risk that exceeds 1E-04

CTE = Central Tendency Exposure

ft bgs = feet below ground surface

HI = Hazard Index

RME = Reasonable Maximum Exposure

Table 6-5. Predicted Blood Lead Levels for Construction Workers Exposed to Lead in Soil

Station	Sample	Depth (ft bgs)		Lead Concentration (mg/kg)	Predicted PbB (ug/dL)		P10 (fetal)
		Top	Bottom		PbB (GM, adult)	PbB (GM, fetal)	
01	01-VBOU3-SB-0001-B	0.33	0.83	11	1.36	1.23	0.25%
	01-VBOU3-SB-0001-C	1.50	3.00	16	1.36	1.23	0.25%
	01-VBOU3-SB-0001-D	5.83	6.92	18	1.36	1.23	0.25%
02	01-VBOU3-SB-0002-A	0.33	2.50	8.9	1.36	1.23	0.25%
	01-VBOU3-SB-0002-B	4.00	5.00	9	1.36	1.23	0.25%
	01-VBOU3-SB-0002-C	8.50	10.00	30	1.37	1.23	0.25%
	01-VBOU3-SB-0002-D	12.00	13.00	7.1	1.36	1.23	0.25%
03	01-VBOU3-SB-0003-A	0.17	2.00	270	1.42	1.28	0.29%
	01-VBOU3-SB-0003-B	2.00	3.50	11	1.36	1.23	0.25%
	01-VBOU3-SB-0003-C	5.00	6.17	10	1.36	1.23	0.25%
	01-VBOU3-SB-0003-D	10.50	11.00	13	1.36	1.23	0.25%
04	01-VBOU3-SB-0004-A	0.08	3.00	190	1.40	1.26	0.28%
	01-VBOU3-SB-0004-B	6.00	10.00	11	1.36	1.23	0.25%
	01-VBOU3-SB-0004-C	10.00	12.50	9.4	1.36	1.23	0.25%
	01-VBOU3-SB-0004-D	15.50	17.00	8.5	1.36	1.23	0.25%
05	01-VBOU3-SB-0005-A	0.00	0.50	160	1.39	1.26	0.27%
	01-VBOU3-SB-0005-B	0.83	2.50	6.4	1.36	1.23	0.25%
	01-VBOU3-SB-0005-C	6.50	7.50	11	1.36	1.23	0.25%
06	01-VBOU3-SB-0006-A	1.00	4.50	110	1.38	1.25	0.26%
	01-VBOU3-SB-0006-B	5.00	6.50	170	1.40	1.26	0.27%
	01-VBOU3-SB-0006-C	7.00	10.00	18	1.36	1.23	0.25%
07	01-VBOU3-SB-0007-A	0.33	5.00	8.9	1.36	1.23	0.25%
	01-VBOU3-SB-0007-B	5.00	10.00	430	1.45	1.31	0.32%
	01-VBOU3-SB-0007-C	10.50	12.00	1,600	1.71	1.54	0.61%
	01-VBOU3-SB-0007-D	14.00	15.00	32	1.37	1.23	0.25%
	01-VBOU3-SB-0007-E	20.67	22.00	17	1.36	1.23	0.25%
08	01-VBOU3-SB-0008-A	0.25	2.00	400	1.45	1.30	0.32%
	01-VBOU3-SB-0008-B	4.00	6.00	160	1.39	1.26	0.27%
	01-VBOU3-SB-0008-C	7.00	9.50	17	1.36	1.23	0.25%
	01-VBOU3-SB-0008-D	24.00	25.00	40	1.37	1.23	0.25%
09	01-VBOU3-SB-0009-A	0.25	2.00	100	1.38	1.24	0.26%
	01-VBOU3-SB-0009-B	5.50	7.00	11	1.36	1.23	0.25%
	01-VBOU3-SB-0009-C	8.50	9.50	18	1.36	1.23	0.25%
	01-VBOU3-SB-0009-D	23.00	24.00	17	1.36	1.23	0.25%
10	01-VBOU3-SB-C010-A	0.50	1.50	12	1.36	1.23	0.25%
	01-VBOU3-SB-0010-B	2.00	2.83	12	1.36	1.23	0.25%
	01-VBOU3-SB-0010-C	5.00	5.92	12	1.36	1.23	0.25%
	01-VBOU3-SB-0010-D	8.00	9.00	18	1.36	1.23	0.25%
12	01-VBOU3-SB-0012-A	0.25	0.75	360	1.44	1.29	0.31%
	01-VBOU3-SB-0012-B	2.00	3.00	36	1.37	1.23	0.25%
13	01-VBOU3-SB-0013-A	0.00	0.75	130	1.39	1.25	0.27%
	01-VBOU3-SB-0013-B	4.50	5.00	14	1.36	1.23	0.25%

Table 6-5. Predicted Blood Lead Levels for Construction Workers Exposed to Lead in Soil (Continued)

Station	Sample	Depth (ft bgs)		Lead Concentration (mg/kg)	Predicted PbB (ug/dL)		P10 (fetal)
		Top	Bottom		PbB (GM, adult)	PbB (GM, fetal)	
14	01-VBOU3-SB-0014-A	3.00	5.00	13	1.36	1.23	0.25%
	01-VBOU3-SB-0014-B	8.08	9.25	11	1.36	1.23	0.25%
	01-VBOU3-SB-0014-C	19.00	20.00	12	1.36	1.23	0.25%
15	01-VBOU3-SB-0015-A	0.25	5.00	280	1.42	1.28	0.29%
	01-VBOU3-SB-0015-B	5.00	8.00	24	1.37	1.23	0.25%
	01-VBOU3-SB-0015-C	11.00	12.00	18	1.36	1.23	0.25%
16	01-VBOU3-SB-0016-A	1.00	2.50	5.1	1.36	1.22	0.25%
	01-VBOU3-SB-0016-B	6.50	9.00	10	1.36	1.23	0.25%
	01-VBOU3-SB-0016-D	10.00	11.08	15	1.36	1.23	0.25%
17	01-VBOU3-SB-0017-A	0.25	3.00	43	1.37	1.23	0.25%
	01-VBOU3-SB-0017-B	5.00	6.08	7.2	1.36	1.23	0.25%
	01-VBOU3-SB-0017-C	9.25	10.50	16	1.36	1.23	0.25%
	01-VBOU3-SB-0017-D	11.00	12.50	3.4	1.36	1.22	0.25%
18	01-VBOU3-SB-0018-A	2.00	5.00	44	1.37	1.23	0.25%
	01-VBOU3-SB-0018-B	5.00	6.00	12	1.36	1.23	0.25%
	01-VBOU3-SB-0018-C	6.00	8.00	7.8	1.36	1.23	0.25%
19	01-VBOU3-SB-0019-A	8.00	9.08	11	1.36	1.23	0.25%
	01-VBOU3-SB-0019-B	11.00	11.83	22	1.36	1.23	0.25%
20	01-VBOU3-SB-0020-A	2.00	3.00	7.3	1.36	1.23	0.25%
	01-VBOU3-SB-0020-B	8.75	10.00	18	1.36	1.23	0.25%
21	01-VBOU3-SB-0021-A	0.50	2.00	210	1.41	1.27	0.28%
	01-VBOU3-SB-0021-B	4.50	5.50	15	1.36	1.23	0.25%
	01-VBOU3-SB-0021-C	8.00	9.00	13	1.36	1.23	0.25%
22	01-VBOU3-SB-0022-A	2.00	4.00	380	1.44	1.30	0.31%
	01-VBOU3-SB-0022-B	6.00	8.50	140	1.39	1.25	0.27%
	01-VBOU3-SB-0022-C	10.50	12.00	15	1.36	1.23	0.25%
	01-VBOU3-SB-0022-D	21.00	23.00	16	1.36	1.23	0.25%
23	01-VBOU3-SB-0023-A	0.08	1.50	35	1.37	1.23	0.25%
	01-VBOU3-SB-0023-B	2.00	5.00	21	1.36	1.23	0.25%
	01-VBOU3-SB-0023-C	10.00	10.67	15	1.36	1.23	0.25%
24	01-VBOU3-SB-0024-A	0.50	3.00	10	1.36	1.23	0.25%
	01-VBOU3-SB-0024-D	6.50	7.50	14	1.36	1.23	0.25%
25	01-VBOU3-SB-0025-A	0.17	1.50	7.6	1.36	1.23	0.25%
	01-VBOU3-SB-0025-B	5.50	6.00	6.5	1.36	1.23	0.25%
26	01-VBOU3-SB-0026-A	0.25	2.83	23	1.36	1.23	0.25%
	01-VBOU3-SB-0026-B	3.00	4.50	50	1.37	1.23	0.25%
27	01-VBOU3-SB-0027-A	0.17	3.00	19	1.36	1.23	0.25%
	01-VBOU3-SB-0027-B	5.00	9.00	40	1.37	1.23	0.25%
	01-VBOU3-SB-0027-C	13.00	14.17	9.2	1.36	1.23	0.25%
	01-VBOU3-SB-0027-D	17.00	18.00	11	1.36	1.23	0.25%
	01-VBOU3-SB-0027-E	20.33	21.00	16	1.36	1.23	0.25%

Table 6-5. Predicted Blood Lead Levels for Construction Workers Exposed to Lead in Soil (Continued)

Station	Sample	Depth (ft bgs)		Lead Concentration (mg/kg)	Predicted PbB (ug/dL)		P10 (fetal)
		Top	Bottom		PbB (GM, adult)	PbB (GM, fetal)	
28	01-VBOU3-SB-0028-A	0.92	1.92	12	1.36	1.23	0.25%
	01-VBOU3-SB-0028-B	10.00	10.50	9.1	1.36	1.23	0.25%
	01-VBOU3-SB-0028-C	14.00	15.00	19	1.36	1.23	0.25%
	01-VBOU3-SB-0028-D	19.00	20.00	16	1.36	1.23	0.25%
	01-VBOU3-SB-0028-E	24.00	25.50	11	1.36	1.23	0.25%
29	01-VBOU3-SB-0029-A	1.83	2.83	15	1.36	1.23	0.25%
	01-VBOU3-SB-0029-B	5.00	5.50	14	1.36	1.23	0.25%
	01-VBOU3-SB-0029-C	11.00	11.92	21	1.36	1.23	0.25%
	01-VBOU3-SB-0029-D	15.50	16.33	13	1.36	1.23	0.25%
	01-VBOU3-SB-0029-E	20.00	21.00	27	1.37	1.23	0.25%
30	01-VBOU3-SB-0030-A	0.00	0.50	22	1.36	1.23	0.25%
	01-VBOU3-SB-0030-B	1.00	3.00	15	1.36	1.23	0.25%
	01-VBOU3-SB-0030-C	9.00	10.50	6.4	1.36	1.23	0.25%
31	01-VBOU3-SB-0031-A	0.83	2.00	17	1.36	1.23	0.25%
	01-VBOU3-SB-0031-B	5.00	6.17	14	1.36	1.23	0.25%
	01-VBOU3-SB-0031-C	10.00	11.00	10	1.36	1.23	0.25%
32	01-VBOU3-SB-0032-A	0.33	2.50	110	1.38	1.25	0.26%
	01-VBOU3-SB-0032-B	6.00	8.50	230	1.41	1.27	0.28%
	01-VBOU3-SB-0032-C	9.00	10.50	21	1.36	1.23	0.25%
	01-VBOU3-SB-0032-D	13.83	15.00	24	1.37	1.23	0.25%
	01-VBOU3-SB-0032-E	24.00	25.00	18	1.36	1.23	0.25%
33	01-VBOU3-SB-0033-A	0.33	2.50	21	1.36	1.23	0.25%
	01-VBOU3-SB-0033-B	3.00	4.00	12	1.36	1.23	0.25%
	01-VBOU3-SB-0033-C	9.00	10.00	9.3	1.36	1.23	0.25%
	01-VBOU3-SB-0033-D	15.67	16.50	0.4	1.36	1.22	0.25%
	01-VBOU3-SB-0033-E	18.00	18.50	18	1.36	1.23	0.25%
34	01-VBOU3-SB-0034-A	0.33	2.33	19	1.36	1.23	0.25%
	01-VBOU3-SB-0034-B	4.50	6.50	12	1.36	1.23	0.25%
	01-VBOU3-SB-0034-C	11.00	13.00	12	1.36	1.23	0.25%
	01-VBOU3-SB-0034-E	18.00	19.50	4.1	1.36	1.22	0.25%
	01-VBOU3-SB-0034-F	21.00	22.00	12	1.36	1.23	0.25%
35	01-VBOU3-SB-0035-A	0.50	3.50	11	1.36	1.23	0.25%
	01-VBOU3-SB-0035-B	9.00	9.67	3.3	1.36	1.22	0.25%
	01-VBOU3-SB-0035-C	9.83	10.83	20	1.36	1.23	0.25%
36	01-VBOU3-SB-0036-A	0.25	3.50	21	1.36	1.23	0.25%
	01-VBOU3-SB-0036-B	5.00	10.00	13	1.36	1.23	0.25%
	01-VBOU3-SB-0036-C	11.00	12.00	19	1.36	1.23	0.25%
37	01-VBOU3-SB-0037-A	0.00	1.00	30	1.37	1.23	0.25%
	01-VBOU3-SB-0037-B	5.83	7.00	16	1.36	1.23	0.25%
	01-VBOU3-SB-0037-C	10.00	11.17	12	1.36	1.23	0.25%

Shading indicates probabilitly of fetal blood lead concentration that exceeds USEPA's recommended level (P10<5%)

ft bgs = feet below ground surface

GM = Geometric mean

P10 = Probability (%) that a blood lead level exceeds 10 ug/dL

Table 6-6. Estimated Risks to Future On-Site Commercial Workers from Ingestion of Groundwater

Sample Type	Sample Location	Number of Samples	NON-CANCER HI		CANCER RISK	
			CTE	RME	CTE	RME
Dissolved	04	1	3E+01	4E+01	2E-06	2E-05
	07	1	4E+00	6E+00	2E-05	2E-04
	MW-32	2	5E-01	7E-01	2E-06	2E-05
	MW-33	4	1E+00	2E+00	2E-06	1E-05
	MW-34	3	5E-01	7E-01	9E-07	7E-06
	MW-35	2	2E-01	3E-01	7E-07	5E-06
	MW-36	3	2E+00	3E+00	6E-06	5E-05
Total Recoverable	04	1	2E+01	2E+01	8E-06	6E-05
	07	1	4E+02	6E+02	8E-03	6E-02
	MW-32	2	6E-01	1E+00	2E-06	1E-05
	MW-33	4	3E+00	4E+00	5E-06	4E-05
	MW-34	3	7E-01	1E+00	9E-07	7E-06
	MW-35	0	--	--	--	--
	MW-36	1	1E+00	2E+00	7E-06	5E-05

Shading indicates non-cancer HI that exceeds 1E+00 or cancer risk that exceeds 1E-04

CTE = Central Tendency Exposure

ft bgs = feet below ground surface

HI = Hazard Index

RME = Reasonable Maximum Exposure

-- = Total metals sample not collected at this station

Table 6-7. Comparison of Dissolved and Total Lead Concentrations in On-Site Wells to the Federal Standard for Drinking Water

Sample Type	Sample Location	Depth (ft bgs)	Number of Samples	Lead Concentration [1] (ug/L)	Federal Drinking Water Action Level (ug/L)
Dissolved	04	11	1	1.35	15
	07	12.2	1	2.3	15
	MW-32	5	2	1.5	15
	MW-33	15.8	4	1.5	15
	MW-34	20.3	3	1.5	15
	MW-35	11.2	2	1.5	15
	MW-36	8.5	3	1.5	15
Total Recoverable	04	11	1	42.6	15
	07	12.2	1	15800	15
	MW-32	5	2	1.5	15
	MW-33	15.75	4	7.6	15
	MW-34	20.3	3	1.5	15
	MW-35	11.2	0	--	15
	MW-36	8.5	1	7.2	15

Shading indicates concentrations that exceed the federal action level for lead in drinking water

ft bgs = feet below ground surface

[1] 95th UCL or maximum concentration (whichever value is smaller) for stations where more than one sample was collected.

-- Total metals sample not collected at this station

Table 6-8. Estimated Risks to Future On-Site Residents from Ingestion of Groundwater

Sample Type	Sample Location	Number of Samples	NON-CANCER HI		CANCER RISK	
			CTE	RME	CTE	RME
Dissolved	04	1	6E+01	1E+02	1E-05	7E-05
	07	1	1E+01	2E+01	1E-04	7E-04
	MW-32	2	1E+00	3E+00	9E-06	6E-05
	MW-33	4	4E+00	8E+00	9E-06	6E-05
	MW-34	3	1E+00	2E+00	4E-06	3E-05
	MW-35	2	6E-01	1E+00	3E-06	2E-05
	MW-36	3	6E+00	1E+01	3E-05	2E-04
Total Recoverable	04	1	4E+01	8E+01	4E-05	3E-04
	07	1	1E+03	2E+03	4E-02	2E-01
	MW-32	2	2E+00	3E+00	9E-06	6E-05
	MW-33	4	8E+00	2E+01	2E-05	2E-04
	MW-34	3	2E+00	4E+00	4E-06	3E-05
	MW-35	0	--	--	--	--
	MW-36	1	4E+00	8E+00	3E-05	2E-04

Shading indicates non-cancer HI that exceeds 1E+00 or cancer risk that exceeds 1E-04

CTE = Central Tendency Exposure

ft bgs = feet below ground surface

HI = Hazard Index

RME = Reasonable Maximum Exposure

-- = Total metals sample not collected at this station

Table 6-9. Estimated Risks to Off-Site Future Residents from Ingestion of Groundwater

Sample Type	Sample Location	Number of Samples	NON-CANCER HI		CANCER RISK	
			CTE	RME	CTE	RME
Dissolved	BH-12	5	7E-01	2E+00	3E-05	2E-04
	GW-15	1 or 39 [1]	5E+00	1E+01	1E-05	9E-05
	GW-16	1 or 6 [1]	2E+00	5E+00	8E-06	6E-05
	GW-17	1 or 4 [1]	1E+00	2E+00	4E-05	2E-04
	GW-46	1 or 39 [1]	1E+00	3E+00	1E-05	7E-05
	PS-1	1	7E-01	1E+00	2E-06	1E-05
	PS-3	1	8E-01	2E+00	4E-06	3E-05
	PS-4	1	6E-01	1E+00	4E-06	2E-05
	PS-5	1	2E+00	3E+00	2E-06	1E-05
	PS-6	1	3E+00	5E+00	2E-06	1E-05
	PS-7	1	3E+00	7E+00	9E-06	6E-05
Total Recoverable	BH-12		6E-01	1E+00	3E-05	2E-04
	GW-15	1 or 9 [1]	1E+01	2E+01	3E-04	2E-03
	GW-16	2	3E+00	6E+00	6E-06	4E-05
	GW-17	1	2E+01	3E+01	1E-05	7E-05
	GW-46	1	1E+00	3E+00	2E-06	1E-05
	PS-1	1	2E+01	5E+01	9E-05	6E-04
	PS-3	1	9E+01	2E+02	2E-04	1E-03
	PS-4	1	3E+00	6E+00	1E-05	1E-04
	PS-5	1	1E+01	3E+01	5E-05	3E-04
	PS-6	1	4E+00	9E+00	9E-06	6E-05
	PS-7	1	2E+01	5E+01	2E-04	1E-03

Shading indicates non-cancer HI that exceeds 1E+00 or cancer risk that exceeds 1E-04

CTE = Central Tendency Exposure

ft bgs = feet below ground surface

HI = Hazard Index

RME = Reasonable Maximum Exposure

– = Total metals sample not collected at this station

[1] Total number of data evaluated at this station varies by analyte due to the available groundwater data (some investigations analyzed a restricted set of analytes in groundwater). Thus, the total number of sampling data evaluated is 1 for most metals but is higher at some stations for arsenic, cadmium, and zinc.

Table 6-10. Comparison of Dissolved and Total Lead Concentrations in Off-Site Wells to the Federal Standard for Drinking Water

Sample Type	Sample Location	Number of Samples	Lead Concentration [1] (ug/L)	Federal Drinking Water Action Level (ug/L)
Dissolved	BH-12	5	4.1	15
	GW-15	29	3.2	15
	GW-16	6	6.6	15
	GW-17	4	2.3	15
	GW-46	29	3	15
	PS-1	1	1.5	15
	PS-3	1	1.5	15
	PS-4	1	1.5	15
	PS-5	1	7	15
	PS-6	1	1.5	15
	PS-7	1	1.5	15
Total Recoverable	BH-12	1	61	15
	GW-15	9	38.5	15
	GW-16	2	2	15
	GW-17	1	12	15
	GW-46	1	1.5	15
	PS-1	1	110	15
	PS-3	1	630	15
	PS-4	1	10	15
	PS-5	1	64	15
	PS-6	1	7.2	15
	PS-7	1	120	15

Shading indicates concentrations that exceed the federal action level for lead in drinking water

ft bgs = feet below ground surface

[1] 95th UCL or maximum concentration (whichever value is smaller) for stations where more than one sample was collected.

-- Data not availabe at this station

Table 6-11. Estimated HQs for Terrestrial Plants from Direct Contact with Soils

Sample		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Colorado bkg avg		–	0.2	2.2	0.3	–	37.5	0.2	0.4	0.3	3.3	0.4	0.4	0.5	–	–	40.0	1.3
Station	Horizon																	
001	A	0.1	0.1	0.2	0.1	0.0	15.0	0.5	0.1	0.1	1.6	0.1	0.3	0.7	0.3	0.6	22.0	0.4
002	A	0.1	0.2	0.7	0.0	0.0	9.4	0.3	0.0	0.0	2.2	0.1	0.1	0.7	0.3	0.6	19.0	0.4
003	A	0.1	0.4	0.6	0.2	0.0	9.8	0.3	13.7	1.3	3.6	0.1	0.3	0.7	6.5	0.6	14.0	0.6
004	A	0.1	0.6	0.3	0.0	0.1	7.6	0.1	2.1	0.9	1.2	0.5	0.2	0.7	1.1	0.6	11.5	1.6
005	A	0.1	0.9	0.6	0.1	0.0	8.0	0.2	7.5	0.8	1.5	0.4	0.2	0.7	6.0	0.6	10.0	1.2
006	A	0.1	0.4	3.6	0.3	0.0	23.0	0.4	0.5	0.5	1.3	0.9	0.4	4.0	0.3	0.6	32.0	0.6
007	A	0.1	0.0	0.1	0.0	0.0	11.0	0.1	0.1	0.0	0.8	0.1	0.1	0.7	0.3	0.6	10.5	0.3
008	A	0.4	0.3	1.6	0.1	0.5	20.0	0.2	2.9	1.9	1.7	0.9	0.8	1.3	1.1	0.6	12.0	3.4
009	A	0.1	0.3	0.5	0.0	0.0	19.0	0.2	0.6	0.5	1.6	0.3	0.2	0.7	0.3	0.6	16.0	0.9
010	A	0.1	0.2	1.3	0.1	2.0	11.0	0.5	0.1	0.1	3.1	0.1	0.4	0.7	0.3	0.6	26.5	9.2
012	A	0.1	0.3	0.7	0.1	0.3	18.0	0.3	5.9	1.7	2.8	0.2	0.3	0.7	2.2	0.6	17.0	2.3
013	A	0.1	0.2	0.4	0.1	0.2	15.0	0.2	0.9	0.6	2.2	0.2	0.3	0.7	0.3	0.6	17.0	1.7
014	A	0.1	0.1	0.2	0.1	0.0	16.0	0.2	0.2	0.1	2.6	0.1	0.3	0.7	0.3	0.6	16.0	0.4
015	A	2.0	0.1	1.2	0.1	0.4	18.0	0.2	2.2	1.3	1.6	0.1	0.3	0.7	0.3	0.6	14.0	2.5
016	A	0.1	0.0	0.0	0.0	0.0	2.4	0.1	37.9	0.0	1.3	0.1	0.0	0.7	0.3	0.6	3.8	0.3
017	A	0.1	0.1	0.2	0.0	0.0	3.4	0.1	0.9	0.2	0.8	0.4	0.0	0.7	0.5	0.6	5.5	0.2
018	A	0.1	0.1	0.2	0.0	0.0	11.0	0.2	1.4	0.2	1.1	0.1	0.1	0.7	0.3	0.6	11.0	0.3
019	A	0.1	0.0	0.1	0.1	0.0	14.0	0.2	0.1	0.1	2.7	0.1	0.3	0.7	0.3	0.6	17.0	0.3
020	A	0.1	0.1	0.7	0.1	0.0	5.5	0.3	0.1	0.0	5.9	0.1	0.1	0.7	0.3	0.6	28.5	0.4
021	A	0.1	0.7	0.4	0.0	0.3	14.0	0.2	2.8	1.0	2.2	5.3	0.2	0.7	1.5	0.6	12.0	3.6
022	A	0.4	1.6	0.5	0.0	0.4	6.3	0.1	6.1	1.8	1.8	0.6	0.1	0.7	6.5	0.6	9.5	3.2
023	A	0.1	0.1	0.2	0.0	0.0	13.0	0.2	0.3	0.2	1.8	0.1	0.2	0.7	0.3	0.6	15.0	0.7
024	A	0.1	1.7	1.4	0.0	0.0	8.7	0.4	0.2	0.0	4.6	0.1	0.1	0.7	0.3	0.6	27.5	0.6
025	A	0.1	0.1	1.5	0.0	0.0	5.9	0.4	0.0	0.0	5.4	0.1	0.1	0.7	0.3	0.6	33.0	0.6
026	A	0.1	0.1	0.2	0.0	0.0	16.0	0.2	0.2	0.1	1.4	0.1	0.3	0.7	0.3	0.6	16.5	0.5
027	A	0.1	0.1	0.2	0.0	0.0	16.0	0.2	0.2	0.1	2.0	0.1	0.2	0.7	0.3	0.6	22.0	0.5
028	A	0.1	0.1	0.1	0.1	0.0	14.0	0.2	0.1	0.1	2.1	0.1	0.2	0.7	0.3	0.6	18.5	0.4
029	A	0.1	0.0	0.1	0.1	0.0	17.0	0.3	0.1	0.1	1.9	0.1	0.3	0.7	0.3	0.6	21.0	0.5
030	A	0.1	0.1	0.2	0.1	0.0	15.0	0.2	0.7	0.1	1.7	0.1	0.2	0.7	0.3	0.6	17.0	0.4
031	A	0.1	0.0	0.1	0.1	0.0	16.0	0.2	0.3	0.1	2.0	0.1	0.2	0.7	0.3	0.6	22.5	0.4
032	A	0.1	0.4	0.4	0.1	0.0	17.0	0.2	1.6	0.5	2.2	0.2	0.2	0.7	0.7	0.6	22.0	1.0
033	A	0.1	0.2	0.4	0.1	0.0	13.0	0.2	0.2	0.1	1.6	0.1	0.2	0.7	0.3	0.6	16.0	0.5
034	A	0.1	0.3	0.9	0.1	0.0	13.0	0.7	0.1	0.1	5.1	0.1	0.3	0.7	0.3	1.2	20.0	0.5
035	A	0.1	0.1	0.2	0.0	0.0	12.0	0.2	0.1	0.1	1.3	0.1	0.1	0.7	0.3	0.6	11.0	0.5
036	A	0.1	0.2	0.3	0.1	0.0	14.0	0.2	0.3	0.1	1.6	0.1	0.2	0.7	0.3	0.6	15.0	0.5
037	A	0.1	0.2	0.3	0.1	0.1	13.0	0.2	0.2	0.1	2.7	0.1	0.2	0.7	0.3	0.6	15.5	1.0
001	B	0.1	0.1	0.4	0.1	0.0	13.0	0.5	0.1	0.1	3.8	0.1	0.3	0.7	0.3	0.6	23.0	0.5
002	B	0.1	0.1	0.3	0.0	0.0	11.0	0.5	0.1	0.0	2.2	0.1	0.2	0.7	0.3	0.6	24.5	0.4
003	B	0.1	0.0	1.0	0.1	0.0	12.0	0.1	0.1	0.1	1.9	0.1	0.1	0.7	0.3	0.6	18.5	0.3
004	B	0.1	0.1	0.1	0.0	0.0	15.0	0.2	0.1	0.1	1.4	0.1	0.2	0.7	0.3	0.6	15.5	0.3
005	B	0.1	0.2	1.4	0.0	0.0	10.0	0.2	0.1	0.0	1.1	0.1	0.1	0.7	0.3	0.6	16.5	0.3
006	B	0.1	0.9	0.6	0.1	0.4	16.0	0.2	6.5	0.8	0.7	4.3	0.5	0.7	1.3	6.4	19.5	2.8
007	B	0.7	0.8	2.2	0.1	0.0	71.0	0.5	3.5	2.0	3.6	0.1	2.0	0.7	0.6	0.6	13.0	3.8
008	B	0.1	0.5	0.5	0.0	0.0	10.0	0.2	2.0	0.8	1.8	0.9	0.1	0.7	1.9	0.6	14.5	0.6
009	B	0.1	0.3	1.1	0.0	0.0	8.9	0.4	0.0	0.1	1.6	0.1	0.2	0.7	0.3	0.6	19.0	0.4
010	B	0.1	0.1	0.1	0.0	0.0	12.0	0.2	0.1	0.1	1.8	0.1	0.2	0.7	0.3	0.6	14.0	0.4
012	B	0.1	0.1	0.6	0.1	0.2	13.0	0.3	1.0	0.2	2.3	0.1	0.3	0.7	0.3	0.6	18.0	1.0
013	B	0.1	0.1	0.2	0.1	0.0	18.0	0.2	0.2	0.1	2.3	0.1	0.2	0.7	0.3	0.6	18.5	0.4
014	B	0.1	0.1	0.2	0.1	0.0	14.0	0.4	0.1	0.1	3.7	0.1	0.3	0.7	0.3	0.6	25.0	0.4
015	B	0.1	0.1	0.2	0.1	0.1	13.0	0.2	1.5	0.1	3.2	0.1	0.5	0.7	0.6	0.6	16.0	1.1
016	B	0.1	0.7	3.0	0.0	0.0	7.6	0.4	0.2	0.0	2.5	0.1	0.2	0.7	0.3	0.6	22.5	0.4
017	B	0.1	0.1	2.4	0.0	0.0	6.0	0.3	0.1	0.0	5.6	0.1	0.1	0.7	0.3	0.6	28.0	0.4
018	B	0.1	0.1	2.4	0.0	0.0	7.2	0.4	0.1	0.1	12.5	0.1	0.1	0.7	0.3	0.6	30.5	0.4
019	B	0.1	0.0	0.1	0.1	0.0	15.0	0.2	0.2	0.1	2.9	0.1	0.3	0.7	0.3	0.6	15.5	0.4

Table 6-11. Estimated HQs for Terrestrial Plants from Direct Contact with Soils

Sample		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Colorado bkg avg		--	0.2	2.2	0.3	--	37.5	0.2	0.4	0.3	3.3	0.4	0.4	0.5	--	--	40.0	1.3
Station	Horizon																	
020	B	0.1	0.9	1.9	0.1	0.1	13.0	1.9	0.1	0.1	7.2	0.1	0.9	0.7	0.3	1.2	29.5	0.5
021	B	0.1	0.1	0.1	0.1	0.0	17.0	0.1	0.2	0.1	0.9	0.1	0.2	0.7	0.3	0.6	20.5	0.3
022	B	0.1	0.5	2.4	0.0	0.1	7.3	0.3	2.2	0.7	3.8	0.2	0.1	0.7	1.3	0.6	23.0	0.8
023	B	0.1	0.1	0.1	0.1	0.0	19.0	0.2	0.2	0.1	2.7	0.1	0.3	0.7	0.3	0.6	22.5	0.5
024	B	0.1	0.4	2.2	0.1	0.0	8.0	0.4	0.1	0.1	2.4	0.1	0.1	0.7	0.3	0.6	30.5	0.6
025	B	0.1	0.1	0.3	0.0	0.0	6.5	0.4	0.0	0.0	23.7	0.1	0.1	0.7	0.3	0.6	33.0	0.5
026	B	0.1	0.1	0.2	0.1	0.0	13.0	0.2	0.2	0.2	3.4	0.1	0.2	0.7	0.3	0.6	17.5	0.7
027	B	0.1	0.3	0.6	0.1	0.0	13.0	0.4	0.7	0.2	4.3	0.3	0.3	0.7	0.6	0.6	27.0	1.0
028	B	0.1	0.2	0.4	0.0	0.0	29.0	0.3	0.1	0.0	3.2	0.1	0.2	0.7	0.3	0.6	28.5	0.5
029	B	0.1	0.0	0.1	0.1	0.0	20.0	0.2	0.2	0.1	1.4	0.1	0.3	0.7	0.3	0.6	22.0	0.4
030	B	0.1	0.0	0.1	0.1	0.0	22.0	0.4	0.1	0.1	2.4	0.1	0.3	0.7	0.3	0.6	29.0	0.4
031	B	0.1	0.0	0.1	0.1	0.0	16.0	0.2	0.2	0.1	1.8	0.1	0.2	0.7	0.3	0.6	17.5	0.3
032	B	0.1	0.2	0.6	0.0	0.0	19.0	0.2	0.5	1.1	2.1	0.8	0.3	0.7	0.3	0.6	21.0	1.0
033	B	0.1	0.1	0.2	0.0	0.0	16.0	0.2	0.1	0.1	2.0	0.1	0.2	0.7	0.3	0.6	15.5	0.4
034	B	0.1	0.3	0.5	0.1	0.0	14.0	0.3	0.1	0.1	1.8	0.1	0.1	0.7	0.3	0.6	27.5	0.4
035	B	0.1	0.0	0.1	0.0	0.0	4.5	0.1	0.0	0.0	1.0	0.1	0.1	0.7	0.3	0.6	4.5	0.4
036	B	0.1	0.1	0.2	0.0	0.4	13.0	0.2	0.1	0.1	1.9	0.1	0.2	0.7	0.3	0.6	13.0	2.7
037	B	0.1	0.1	0.1	0.1	0.0	18.0	0.2	0.2	0.1	1.0	0.3	0.3	0.7	0.3	0.6	17.0	0.8
001	C	0.1	0.0	0.1	0.1	0.0	12.0	0.1	0.2	0.1	1.5	0.1	0.1	0.7	0.3	0.6	16.5	0.4
002	C	0.1	0.0	0.1	0.1	0.0	15.0	0.2	0.1	0.1	2.6	0.1	0.2	0.7	0.3	0.6	18.0	0.4
003	C	0.1	0.2	1.2	0.1	0.0	12.0	0.4	0.1	0.0	2.0	0.1	0.2	0.7	0.3	0.6	19.0	0.4
004	C	0.1	0.2	0.8	0.0	5.4	9.9	0.2	0.1	0.0	1.0	0.1	0.2	0.7	0.3	1.2	16.5	16.2
005	C	0.1	0.1	0.7	0.0	0.0	9.1	0.2	0.1	0.1	1.4	0.1	0.1	0.7	0.3	0.6	21.0	0.4
006	C	0.1	0.1	0.1	0.1	0.9	14.0	0.3	0.7	0.1	2.0	0.1	1.3	0.7	0.3	0.6	18.5	4.0
007	C	17.0	93.5	0.5	0.0	4.6	9.8	0.1	32.6	7.6	0.6	5.0	0.8	3.5	14.5	12.0	12.0	7.7
008	C	0.1	0.0	0.1	0.1	0.0	15.0	0.2	0.2	0.1	1.3	0.1	0.2	0.7	0.3	0.6	17.0	0.4
009	C	0.1	0.1	0.1	0.1	0.0	19.0	0.1	0.2	0.1	3.3	0.1	0.2	0.7	0.3	0.6	27.0	0.4
010	C	0.1	0.3	0.1	0.1	0.0	14.0	0.5	0.2	0.1	2.5	0.1	0.3	0.7	0.3	0.6	20.0	0.4
014	C	0.1	0.1	0.3	0.1	0.0	9.2	0.3	0.1	0.1	4.2	0.1	0.2	0.7	0.3	0.6	22.0	0.5
015	C	0.1	0.0	0.1	0.1	0.0	20.0	0.2	0.2	0.1	2.9	0.1	0.2	0.7	0.3	0.6	21.5	0.4
016	C	0.1	0.0	0.1	0.1	0.0	20.0	0.2	0.2	0.1	2.1	0.1	0.3	0.7	0.3	0.6	22.5	0.5
017	C	0.1	0.2	2.2	0.1	0.0	10.0	0.7	0.1	0.1	3.5	0.1	0.2	0.7	0.3	0.6	27.0	0.4
018	C	0.1	0.1	2.4	0.0	0.0	5.9	0.4	0.1	0.0	6.6	0.1	0.1	0.7	0.3	0.6	29.5	0.5
021	C	0.1	0.0	0.1	0.1	0.0	16.0	0.1	0.2	0.1	1.3	0.1	0.2	0.7	0.3	0.6	18.0	0.3
022	C	0.1	0.0	0.1	0.1	0.0	21.0	0.2	0.2	0.1	2.5	0.1	0.3	0.7	0.3	0.6	24.0	0.6
023	C	0.1	0.2	0.1	0.1	0.0	13.0	0.2	0.2	0.1	0.8	0.1	0.2	0.7	0.3	0.6	17.0	0.5
027	C	0.1	0.1	2.2	0.1	0.0	9.9	0.3	0.1	0.0	2.8	0.1	0.1	0.7	0.3	0.6	30.0	0.5
028	C	0.1	0.2	0.1	0.1	0.0	15.0	0.1	0.2	0.1	0.6	0.1	0.2	0.7	0.3	0.6	18.5	0.5
029	C	0.1	0.0	0.1	0.1	0.0	17.0	0.2	0.2	0.1	1.6	0.1	0.3	0.7	0.3	0.6	24.5	0.4
030	C	0.1	0.1	2.4	0.0	0.0	10.0	0.2	0.0	0.0	1.3	0.1	0.1	0.7	0.3	0.6	14.5	0.3
031	C	0.1	0.0	0.1	0.1	0.0	18.0	0.2	0.1	0.0	1.8	0.1	0.3	0.7	0.3	0.6	22.0	0.4
032	C	0.1	0.0	0.1	0.1	0.0	23.0	0.2	0.3	0.1	1.6	0.1	0.3	0.7	0.3	0.6	27.0	0.4
033	C	0.1	0.1	0.1	0.0	0.0	13.0	0.1	0.1	0.0	1.1	0.1	0.1	0.7	0.3	0.6	11.5	0.3
034	C	0.1	0.1	0.1	0.0	0.0	16.0	0.2	0.1	0.1	1.6	0.1	0.2	0.7	0.3	0.6	13.5	0.3
035	C	0.1	0.0	0.0	0.1	0.0	9.1	0.1	0.1	0.1	1.3	0.1	0.2	0.7	0.3	0.6	12.5	0.6
036	C	0.1	0.0	0.1	0.1	0.0	13.0	0.1	0.3	0.1	1.6	0.2	0.1	0.7	0.3	0.6	15.0	0.4
037	C	0.1	0.1	0.0	0.1	0.0	10.0	0.1	0.0	0.1	1.1	0.1	0.1	0.7	0.3	0.6	12.0	0.3
002	D	0.1	0.2	0.7	0.1	0.0	16.0	0.3	0.1	0.0	2.3	0.1	0.2	0.7	0.3	0.6	25.5	0.5
003	D	0.1	0.3	0.7	0.1	0.0	14.0	0.3	0.1	0.1	2.9	0.1	0.2	0.7	0.3	0.6	27.5	0.5
004	D	0.1	0.1	1.1	0.1	0.3	13.0	0.2	0.1	0.0	2.4	0.1	0.2	0.7	0.3	0.6	25.5	5.4
007	D	0.1	0.4	0.3	0.0	18.2	11.0	0.2	0.9	0.2	2.4	0.2	0.2	0.7	0.6	0.6	15.0	26.9
008	D	0.1	0.0	0.1	0.1	0.0	17.0	0.2	0.2	0.2	1.4	0.1	0.3	0.7	0.3	0.6	19.0	0.4
009	D	0.1	0.2	0.1	0.1	0.0	23.0	0.3	0.2	0.1	1.3	0.1	0.4	0.7	0.3	0.6	24.0	0.8
010	D	0.1	0.0	0.1	0.1	0.0	11.0	0.2	0.2	0.1	3.3	0.1	0.2	0.7	0.3	0.6	19.5	0.4

Table 6-11. Estimated HQs for Terrestrial Plants from Direct Contact with Soils

Sample		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Colorado bkg avg		--	0.2	2.2	0.3	--	37.5	0.2	0.4	0.3	3.3	0.4	0.4	0.5	--	--	40.0	1.3
Station	Horizon																	
017	D	0.1	0.0	0.0	0.0	0.0	5.0	0.1	0.1	0.0	0.6	0.1	0.0	0.7	0.3	0.6	5.5	0.1
022	D	0.1	1.5	0.1	0.1	0.0	12.0	0.2	0.4	0.1	0.7	0.1	0.2	0.7	0.3	0.6	20.0	0.8
027	D	0.1	0.3	2.2	0.1	0.0	9.4	0.4	0.2	0.1	2.5	0.1	0.1	0.7	0.3	0.6	36.5	0.5
028	D	0.1	0.1	0.1	0.1	0.0	21.0	0.2	0.2	0.1	0.7	0.1	0.3	0.7	0.3	0.6	23.5	0.4
029	D	0.1	0.0	0.1	0.1	0.0	12.0	0.2	0.1	0.1	1.3	0.1	0.2	0.7	0.3	0.6	16.0	0.4
032	D	0.1	0.0	0.1	0.1	0.0	17.0	0.2	0.2	0.1	2.4	0.2	0.3	0.7	0.3	0.6	25.0	0.6
033	D	0.1	0.0	0.0	0.0	0.0	2.2	0.0	0.1	0.0	0.2	0.1	0.0	0.7	0.3	0.6	2.3	0.2
034	D	0.1	0.0	1.3	0.0	0.0	6.0	0.1	0.0	0.0	0.6	0.1	0.0	0.7	0.3	0.6	8.0	0.2
007	E	0.1	0.2	0.1	0.1	0.0	22.0	0.2	0.2	0.1	1.6	0.1	0.3	0.7	0.3	0.6	24.0	0.5
027	E	0.1	0.1	0.2	0.1	0.0	22.0	0.2	0.3	0.1	4.2	0.1	0.3	0.7	0.3	0.6	25.0	0.5
028	E	0.1	0.1	0.1	0.1	0.0	18.0	0.1	0.2	0.1	0.8	1.3	0.2	0.7	0.3	0.6	21.0	0.4
029	E	0.1	0.0	0.1	0.1	0.0	19.0	0.3	0.3	0.1	2.8	0.3	0.4	0.7	0.3	0.6	22.5	0.6
032	E	0.1	0.1	0.1	0.1	0.0	21.0	0.2	0.2	0.1	1.0	0.1	0.3	0.7	0.3	0.6	22.5	0.6
033	E	0.1	0.2	0.1	0.1	0.0	13.0	0.6	0.1	0.1	1.1	0.1	0.4	0.7	0.3	0.6	14.5	0.5
034	E	0.1	0.2	0.1	0.1	0.0	11.0	0.2	0.1	0.1	2.2	0.1	0.2	0.7	0.3	0.6	14.5	0.5

Table 6-12. Frequency of HQ Values for Terrestrial Plants

Horizon	HQ	Antimony	Arsenic	Beryllium	Cadmium	Cobalt	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium
A	<=1	35	34	36	35	36	25	31	35	36	34	29	35
	1-2	1	2	0	0	0	2	5	0	0	1	3	1
	2-5	0	0	0	1	0	4	0	0	0	1	1	0
	5-10	0	0	0	0	0	3	0	1	0	0	3	0
	>10	0	0	0	0	0	2	0	0	0	0	0	0
B-E	<=1	86	85	87	84	86	81	84	84	85	86	83	83
	1-2	0	1	0	0	1	2	1	1	2	0	3	2
	2-5	0	0	0	1	0	2	1	2	0	1	0	0
	5-10	0	0	0	1	0	1	1	0	0	0	0	1
	>10	1	1	0	1	0	1	0	0	0	0	1	1

Table 6-13. Summary of Phytotoxicity Exceedences by Chemical

Chemical	Total Number of Stations	Number of Stations Exceeding SSLs		
		Avg	EPC	Bkd
Aluminum	11	0	0	0
Antimony	11	0	0	0
Arsenic	11	0	0	0
Barium	11	4	4	0
Beryllium	11	0	0	0
Cadmium	11	0	0	0
Chromium	11	10	10	10
Cobalt	11	0	0	0
Copper	11	0	0	0
Iron	11	0	0	0
Lead	11	0	0	0
Manganese	11	10	10	10
Mercury	11	0	0	0
Nickel	11	0	0	0
Selenium	11	10	10	0
Silver	11	10	10	0
Thallium	11	10	10	10
Vanadium	11	10	10	10
Zinc	11	3	3	0

Avg = Average

Bkd = Background

EPC = Exposure Point Concentration

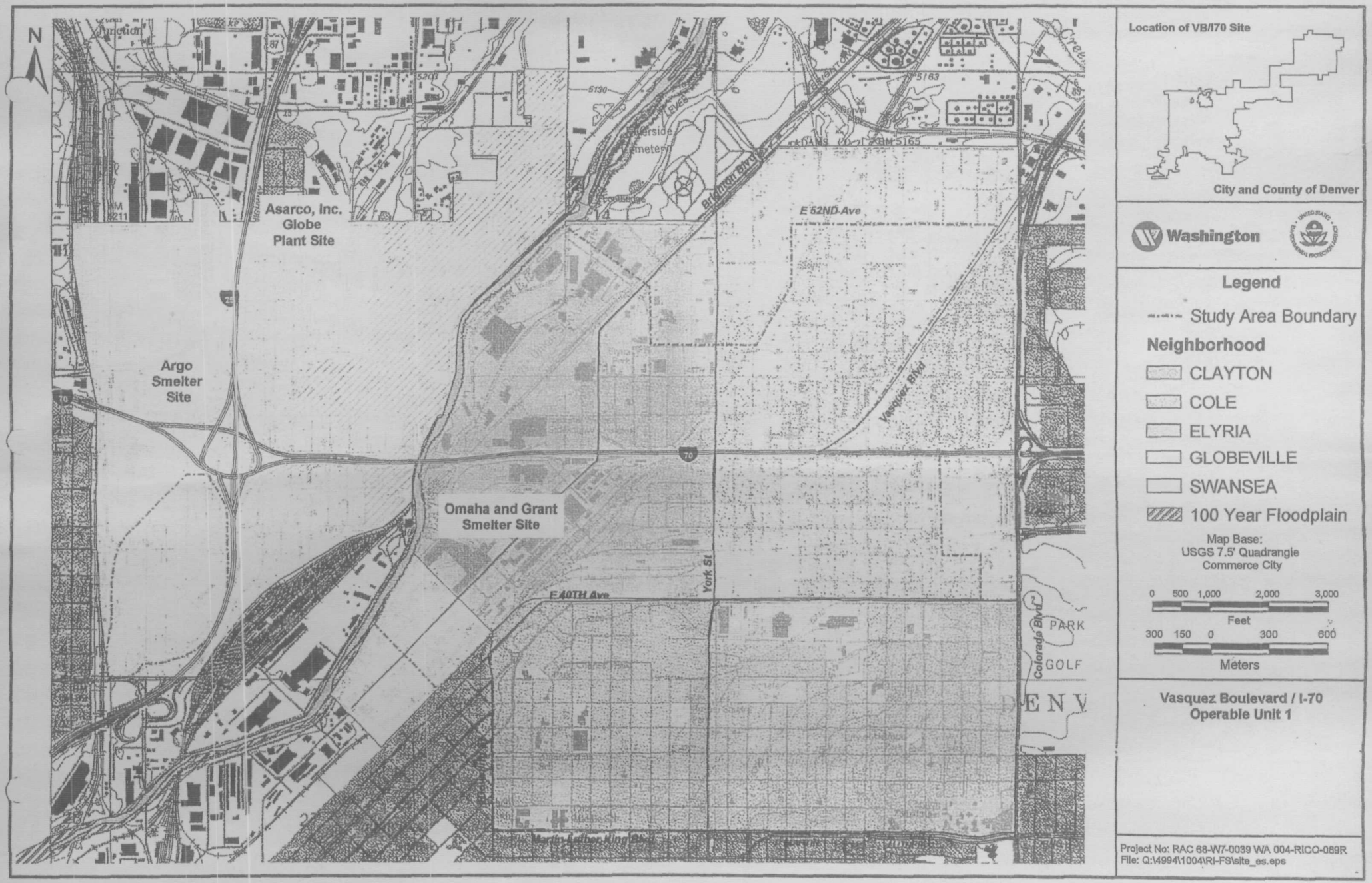
SSL = Soil Screening Level

Table 6-14 Sources and Estimated Direction and Magnitude of Uncertainties in Risk Estimates

Source of Uncertainty	Comment	Probable Direction of Error	Probable Magnitude of Error
Environmental data	Small source areas of soil contamination may not have been indentified.	Unknown	Uncertain; probably not large since samples are biased
Exposure point concentrations for soil	Soil samples collected areas of former smelting operations, and thus may represent high end of contaminant concentrations in soil	Probably high	Uncertain; might be large
Exposure pathways not evaluated	Dermal exposure to chemicals in soil and groundwater, inhalation of particulates and exposure to garden vegetables/garden soil not quantified by risk assessment.	Underestimate risks	Unknown; probably small
Uncertainties in Human Exposure Parameters	Professional judgement used for some exposure parameters, where USEPA recommended values were not available.	Usually tend to overestimate risk	Unknown; probably small
Uncertainties in Chemical Absorption (RBA)	Bioavailablity of non-lead metals in soil could be less than default assumption of 1.0.	Usually tend to overestimate risk	Unknown; probably moderate
	Bioavailablity of lead in soil could be less than or greater than default assumption of 0.6.	Could overestimate or underestimate risk	Unknown; probably moderate
Human toxicity values (RfD, RfC, SF)	All have uncertainty	Usually tend to overestimate risk	Unknown; possibly large
TRVs for terrestrial plants	All have uncertainty; some may be overly conservative (i.e., predict risk at background concentrations)	Usually tend to overestimate risk	Unknown; possibly large
Uncertainties in Chemical Interactions	Synergistic or antagonistic interactions between chemicals are unknown	Unknown	Unknown; probably small

FIGURES

Figure 1-1. Smelters in the Vicinity of the VBI70 Superfund Site



Source: Washington Group International, 2001

Figure 1-2
Site Location

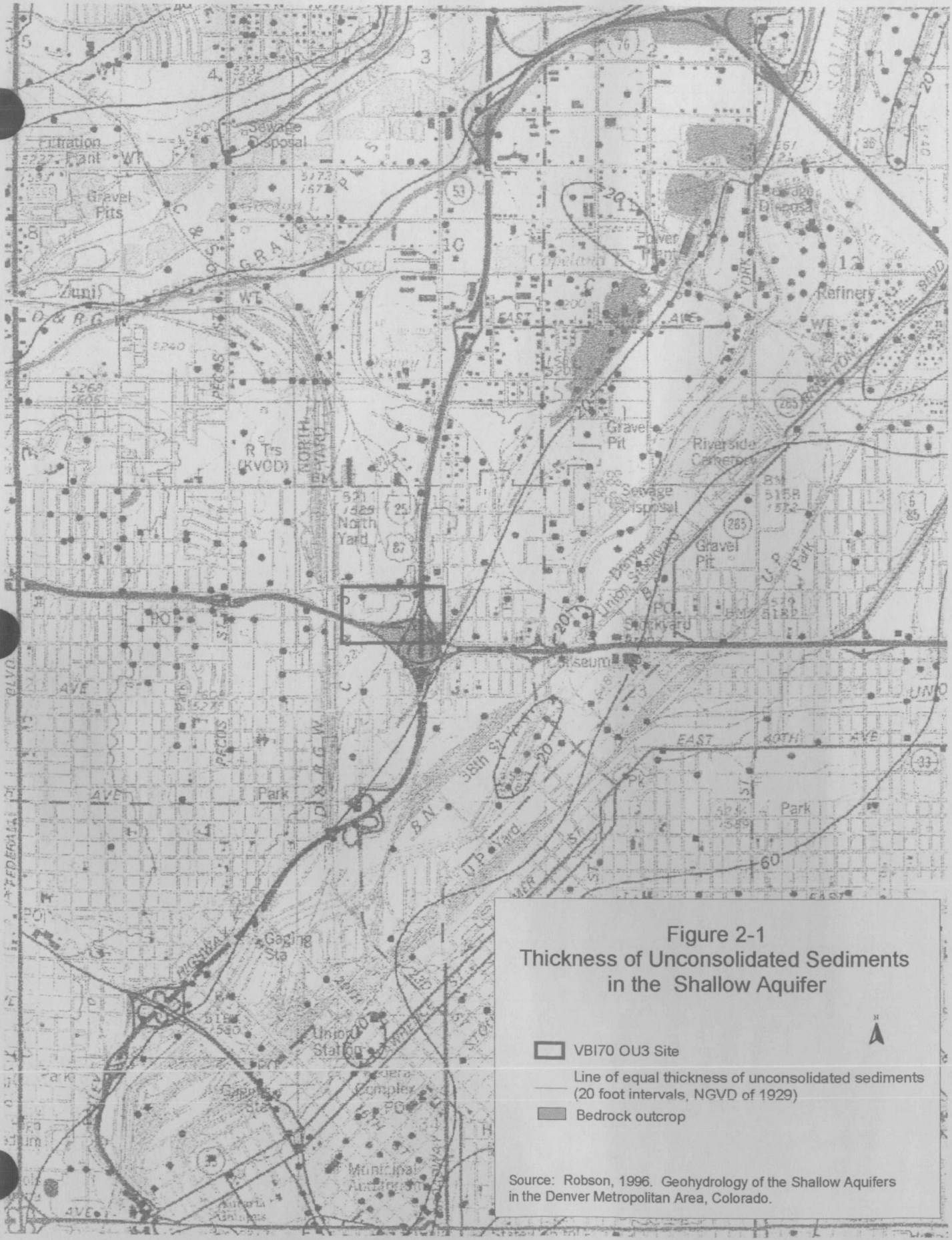


Figure 2-1
Thickness of Unconsolidated Sediments
in the Shallow Aquifer
VBI70 OU3 Site
Line of equal thickness of unconsolidated sediments
(20 foot intervals, NGVD of 1929)
Bedrock outcrop
Source: Robson, 1996. Geohydrology of the Shallow Aquifers
in the Denver Metropolitan Area, Colorado.

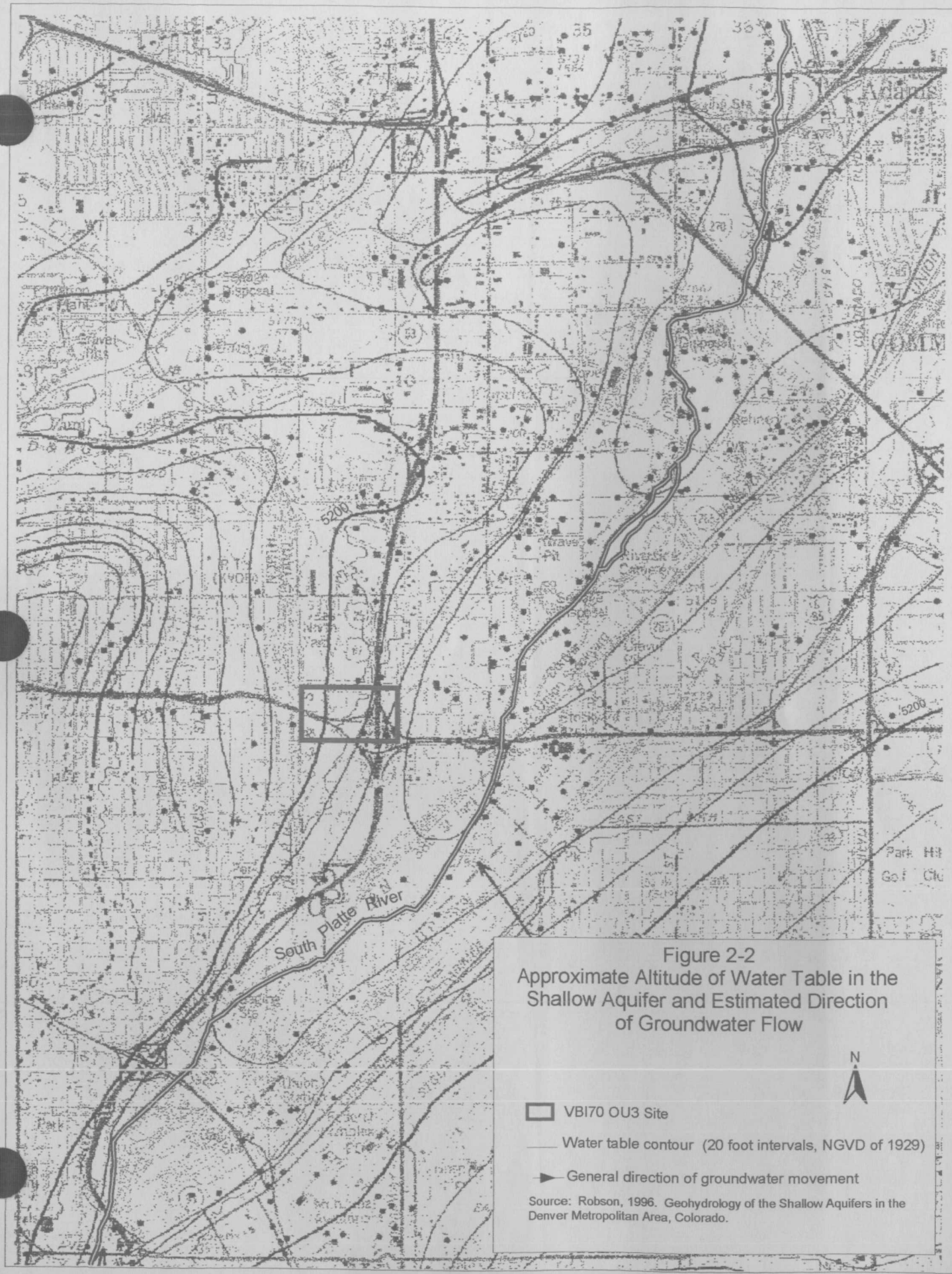
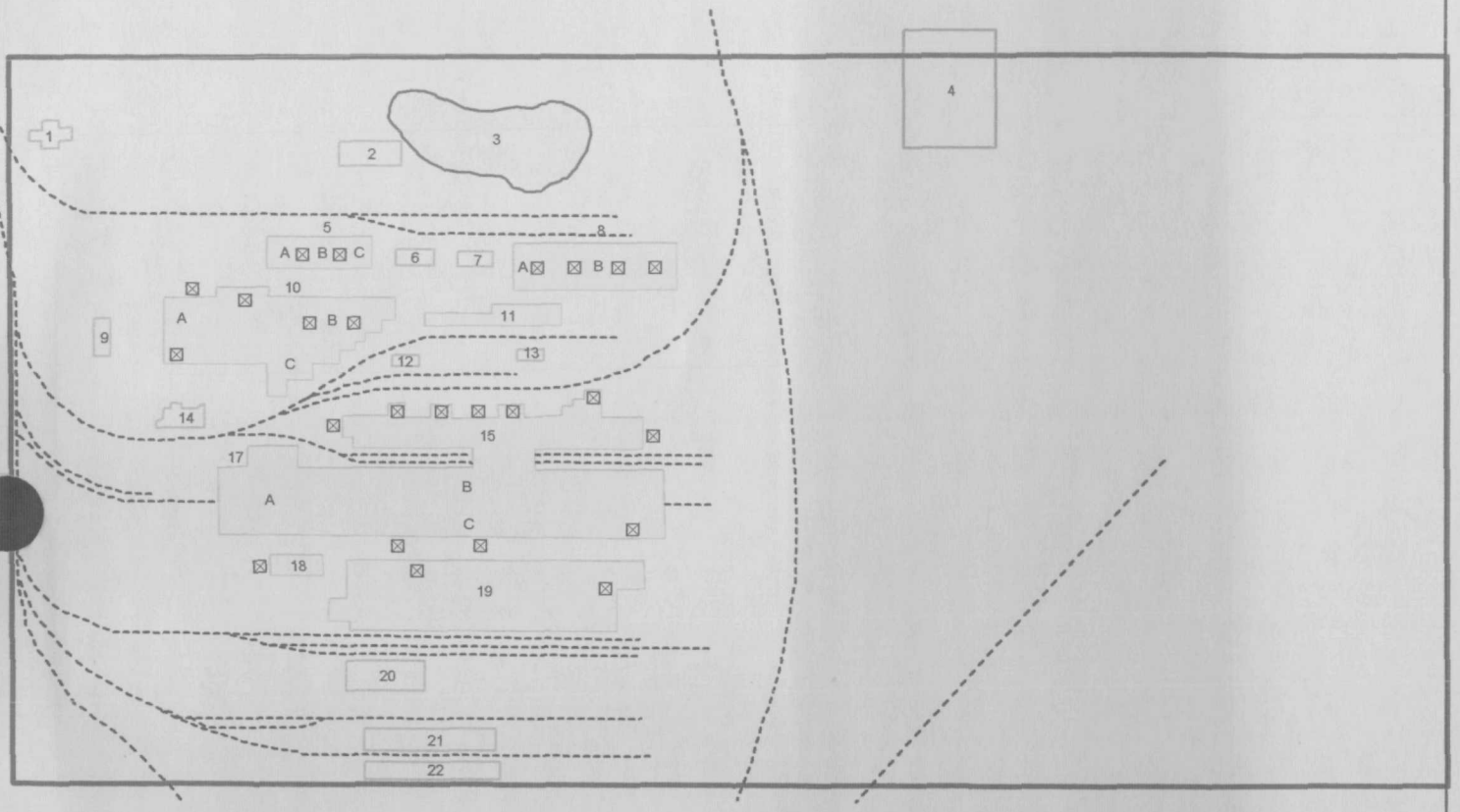


Figure 2-2
Approximate Altitude of Water Table in the Shallow Aquifer and Estimated Direction of Groundwater Flow

Figure 3-2. Historical Buildings at the Former ARGO Smelter



1. Unknown Building
2. Unknown Building
3. Pond
4. Argo School
5. Slag Mill/Copper Furnace
   - A. slag mill
   - B. copper furnace
   - C. storage area
   - D. carpenter
   - E. lumber Shed
8. Smelter House #2
   - A. ore bin
   - B. smelting furnaces
9. Argo Fire House
10. Refinery/Roaster House/Ore Mill
    - A. refinery
    - B. roasters
    - C. ore mill
11. Ore Shed
12. Shed
13. Tin Shop
14. Office
15. Smelter House #1
16. Argo Railroad Station
17. Roaster House #2/Ore Bins
    - A. Copper mill, ore rolls/ crushers, & ore sampling works
    - B. ore bins
    - C. roasters
18. Roaster (old)
19. Roaster House #1/Ore Bins
20. Vacant Building
21. Coal Shed
22. Coal Shed

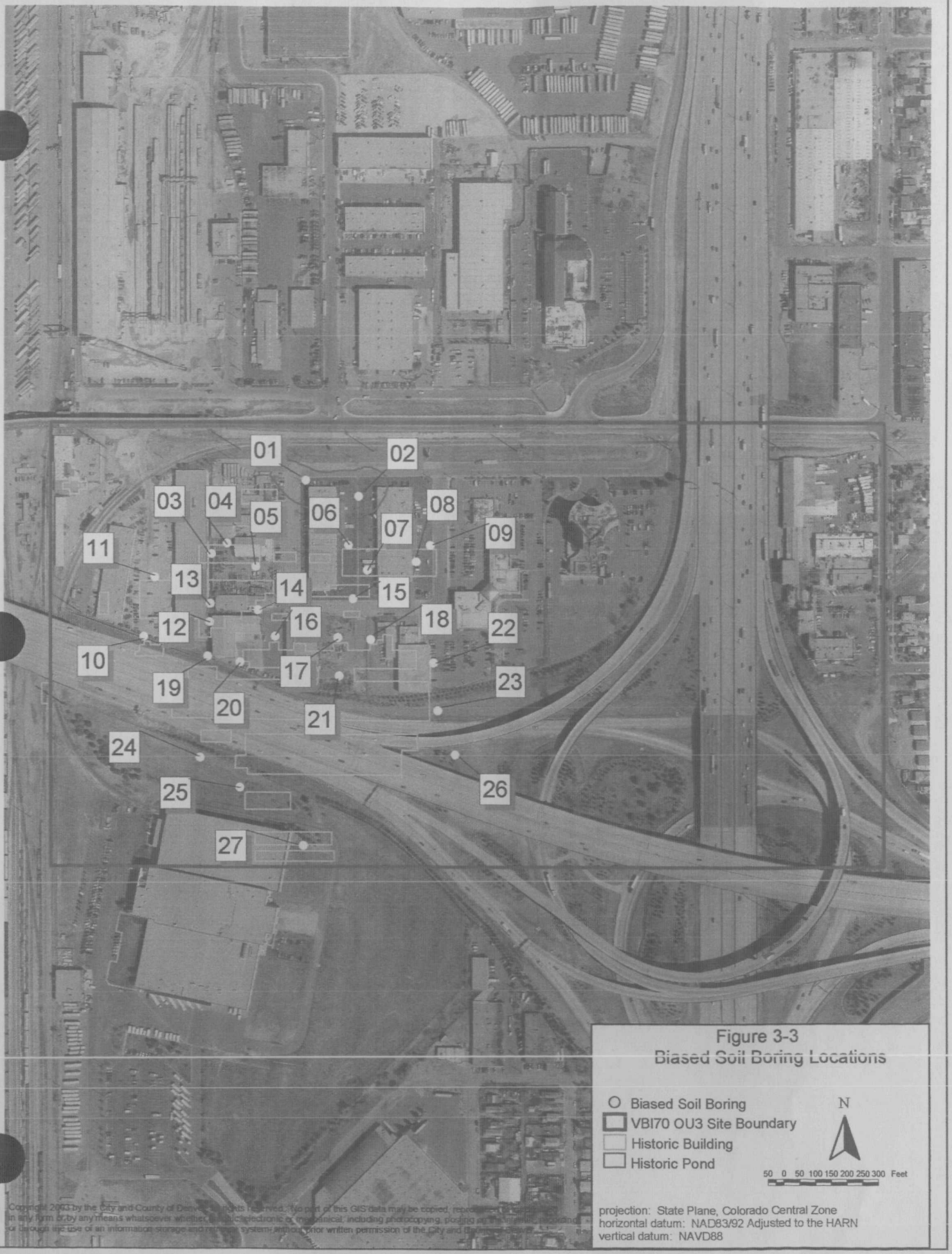
Legend

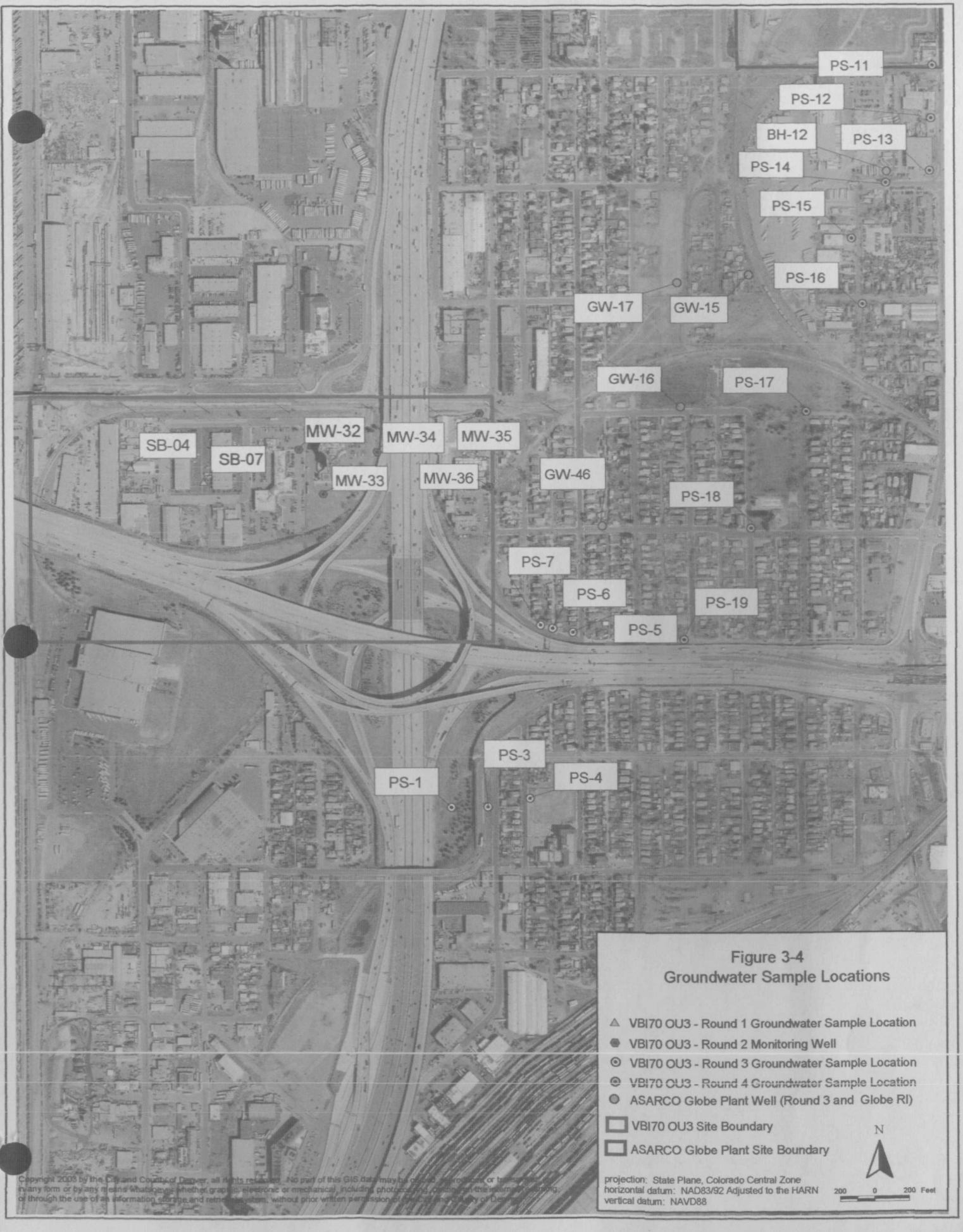
- Study Boundary
- Historic Buildings
- Historic Schools
- Historic Ponds
- Area of Concern
- Historic Railroads
- Historic Chimneys

N

100 0 100 200 Feet

projection: State Plane, Colorado Central Zone
horizontal datum: NAD83/92 Adjusted to the HARN
vertical datum: NAVD88





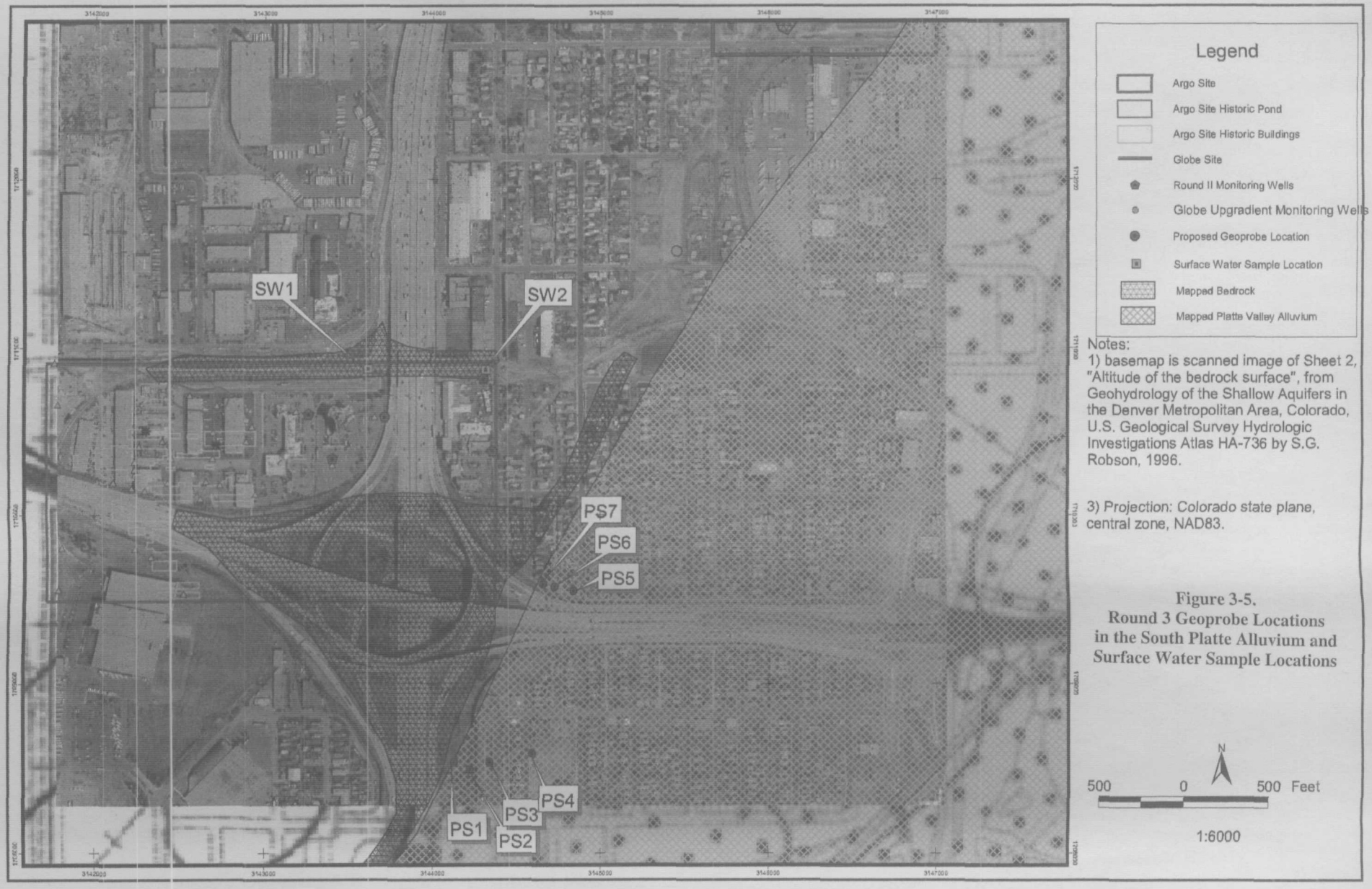
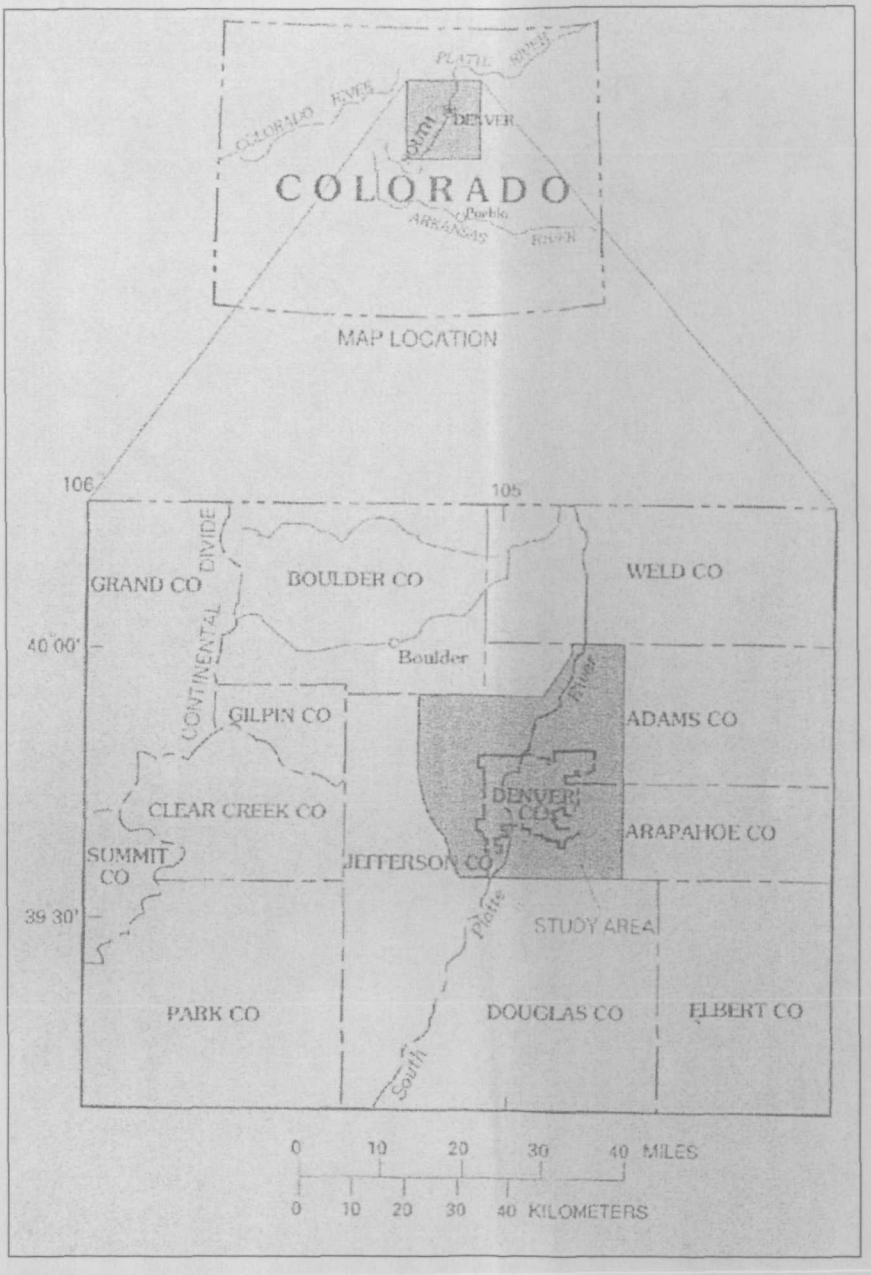


Figure 3-5.
Round 3 Geoprobe Locations in the South Platte Alluvium and Surface Water Sample Locations

Source: Knight Piéso d and Co., Inc. 2005

Figure 4-1. Counties Surrounding the Denver Metropolitan Area



Source: Robson, 1996.

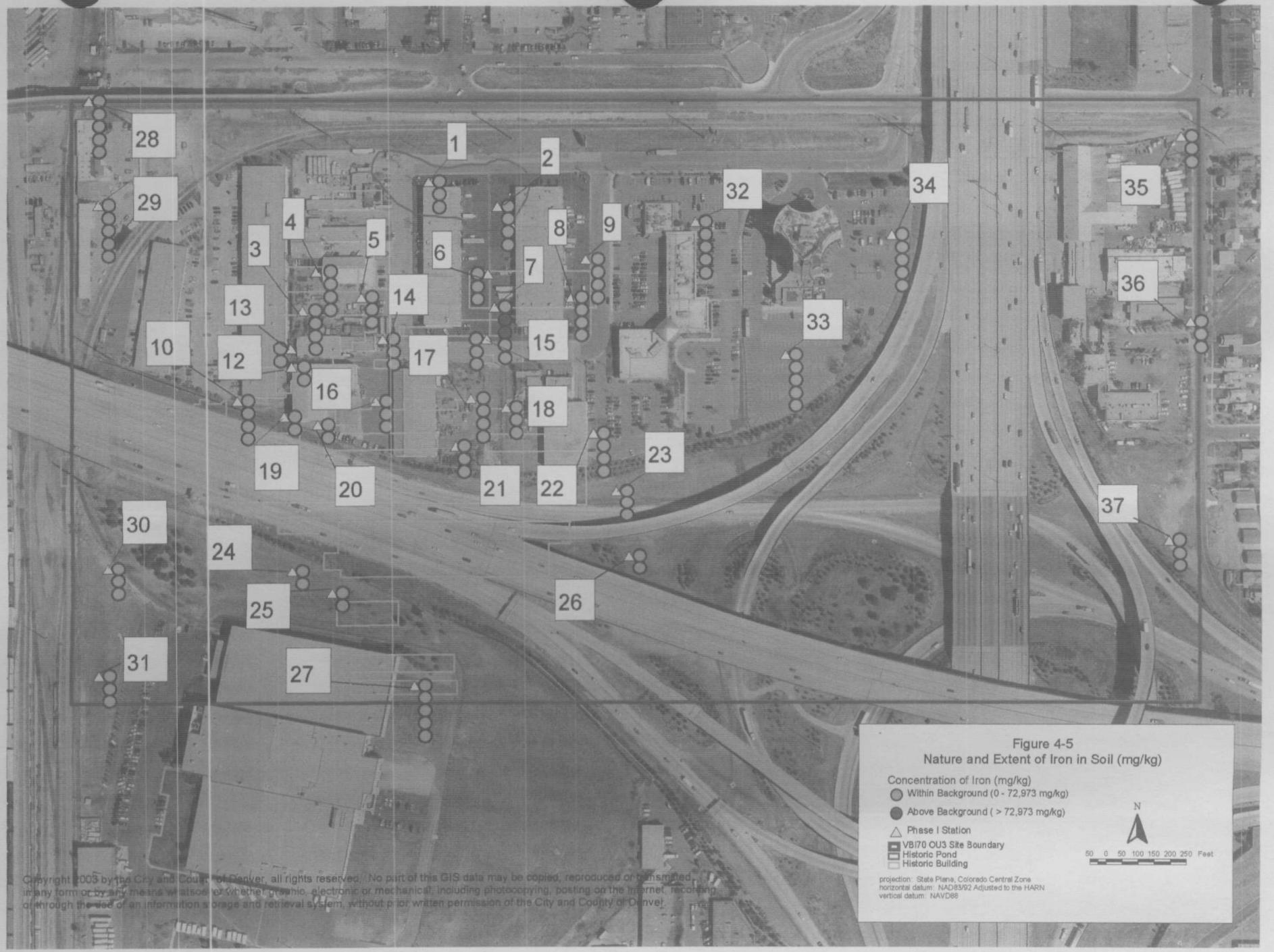
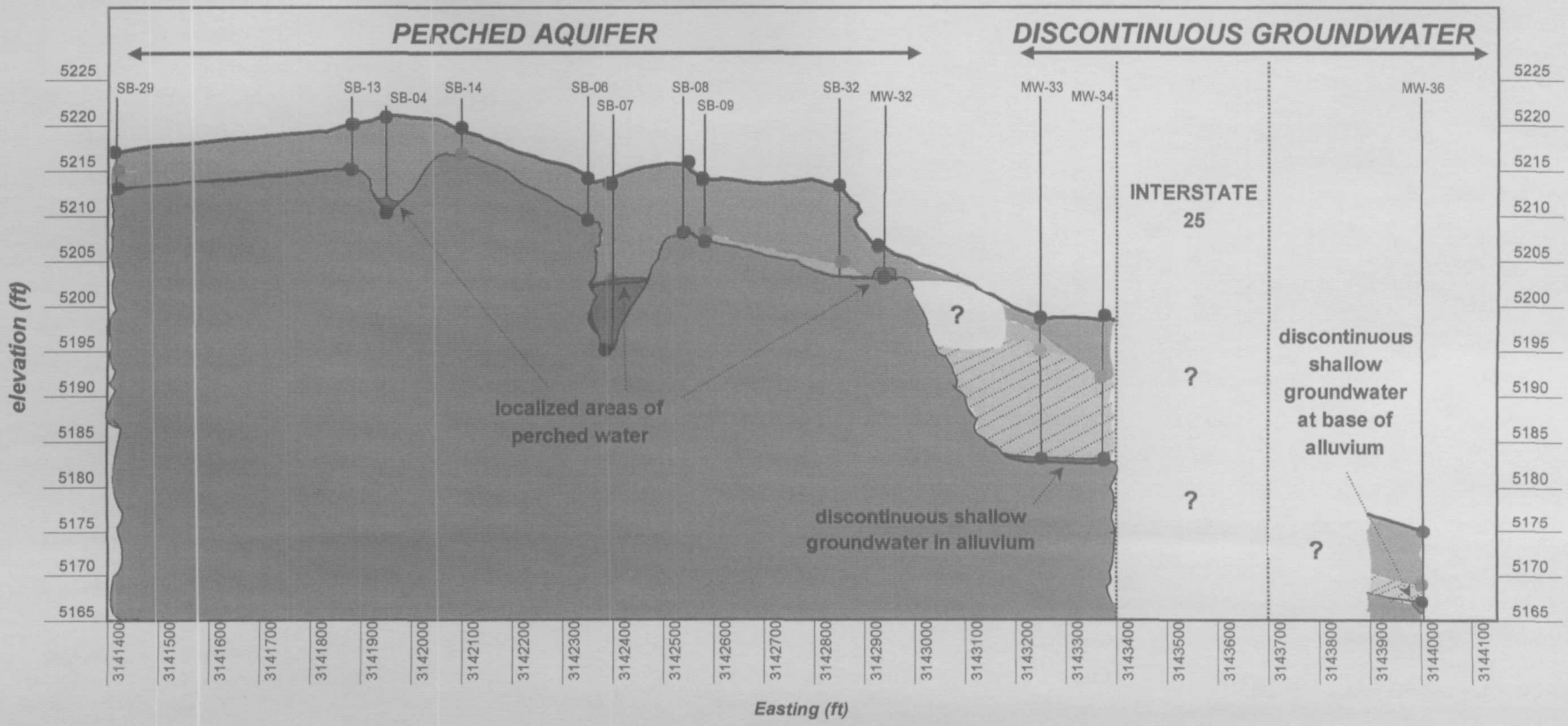


Figure 4-13. Conceptual Model of the Shallow Groundwater at the VBI70 OU3 Site



KEY:

Fill | Silty sandy clay | Plastic, organic, clay | Sandy clay | Claystone

Alluvium (gravelly sand or silty sand) | Water | Data point based on boring log

Note:
Formation contacts between boring logs are inferred
Horizontal and vertical scales are approximate

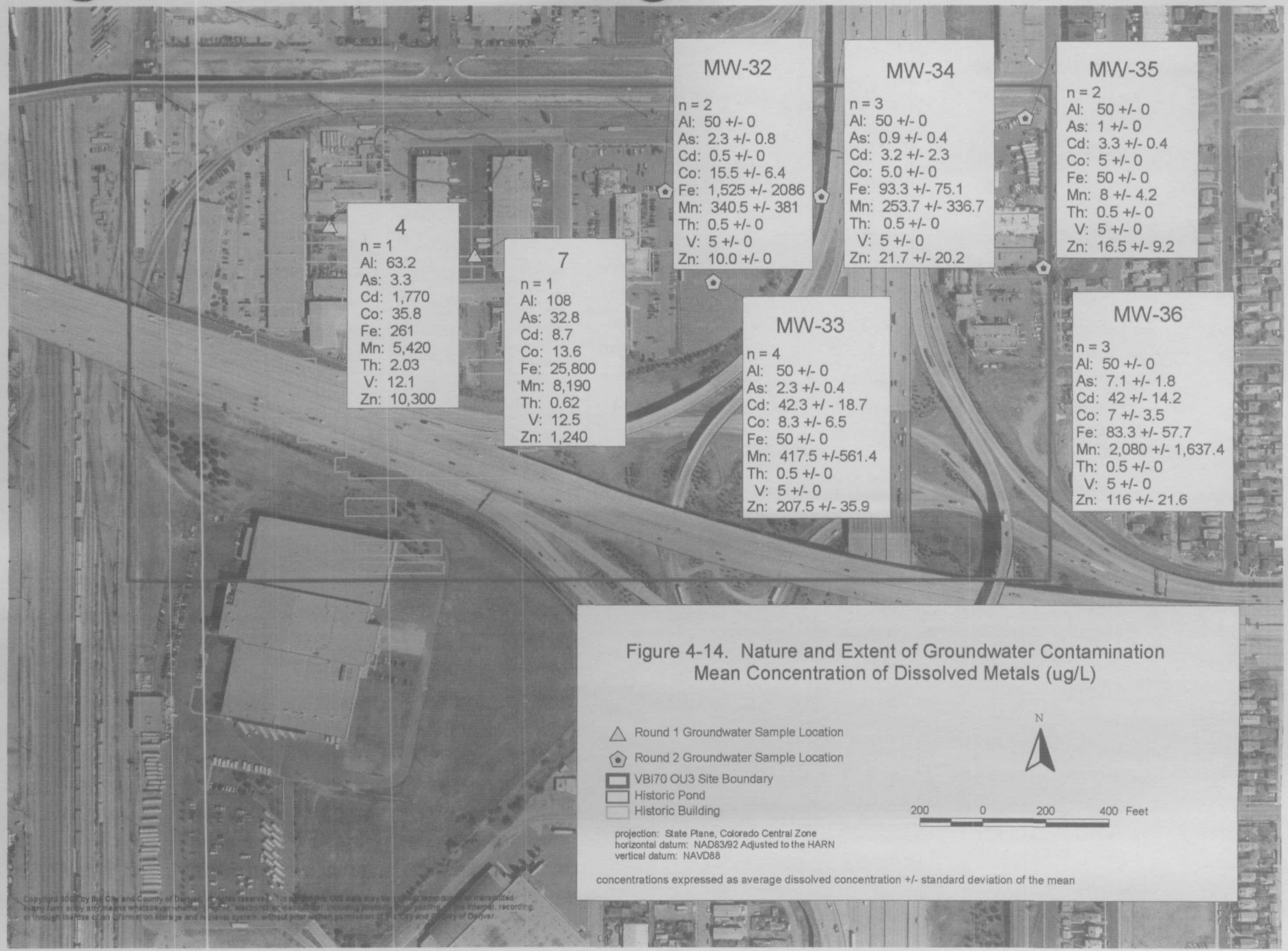
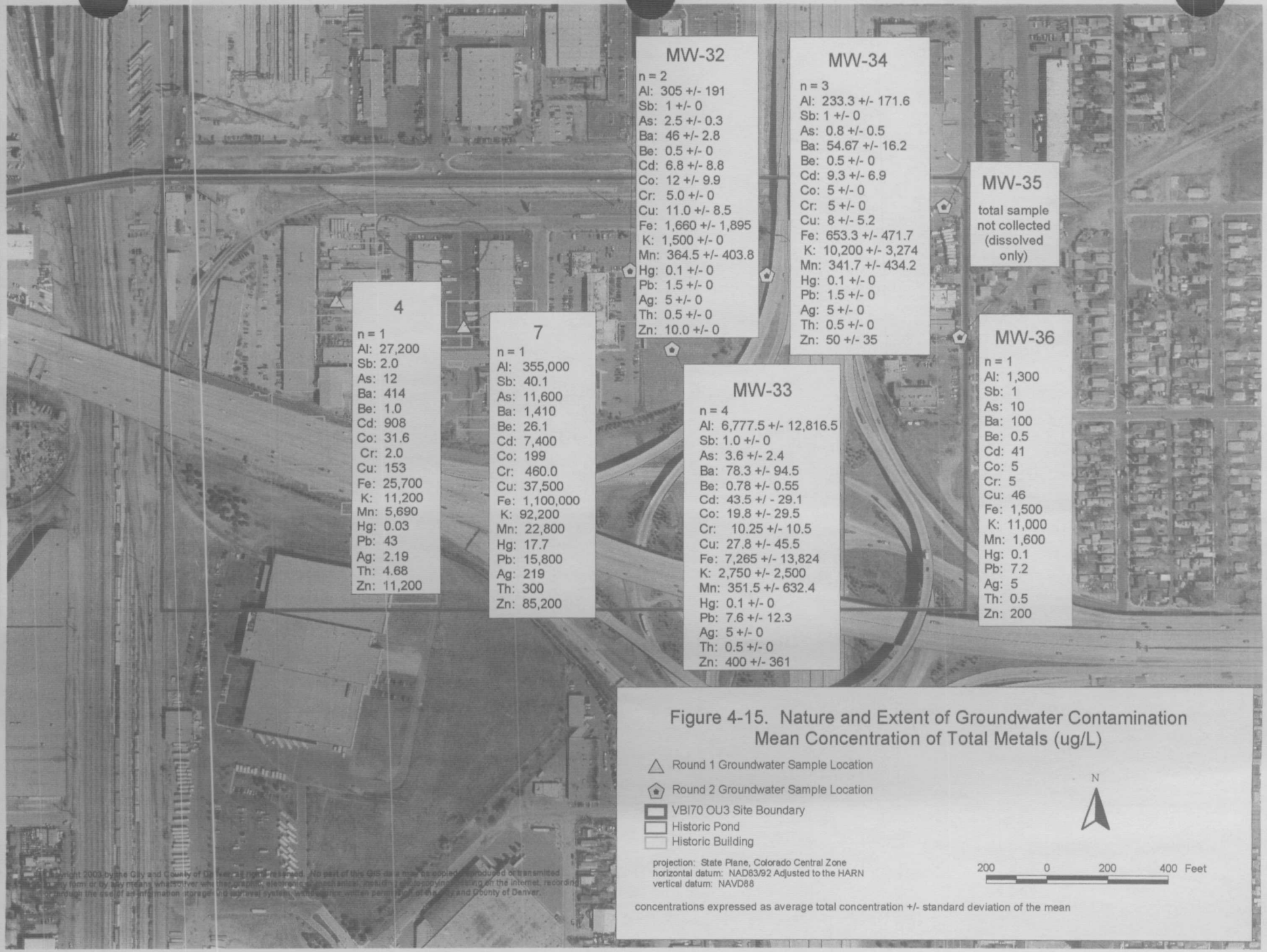
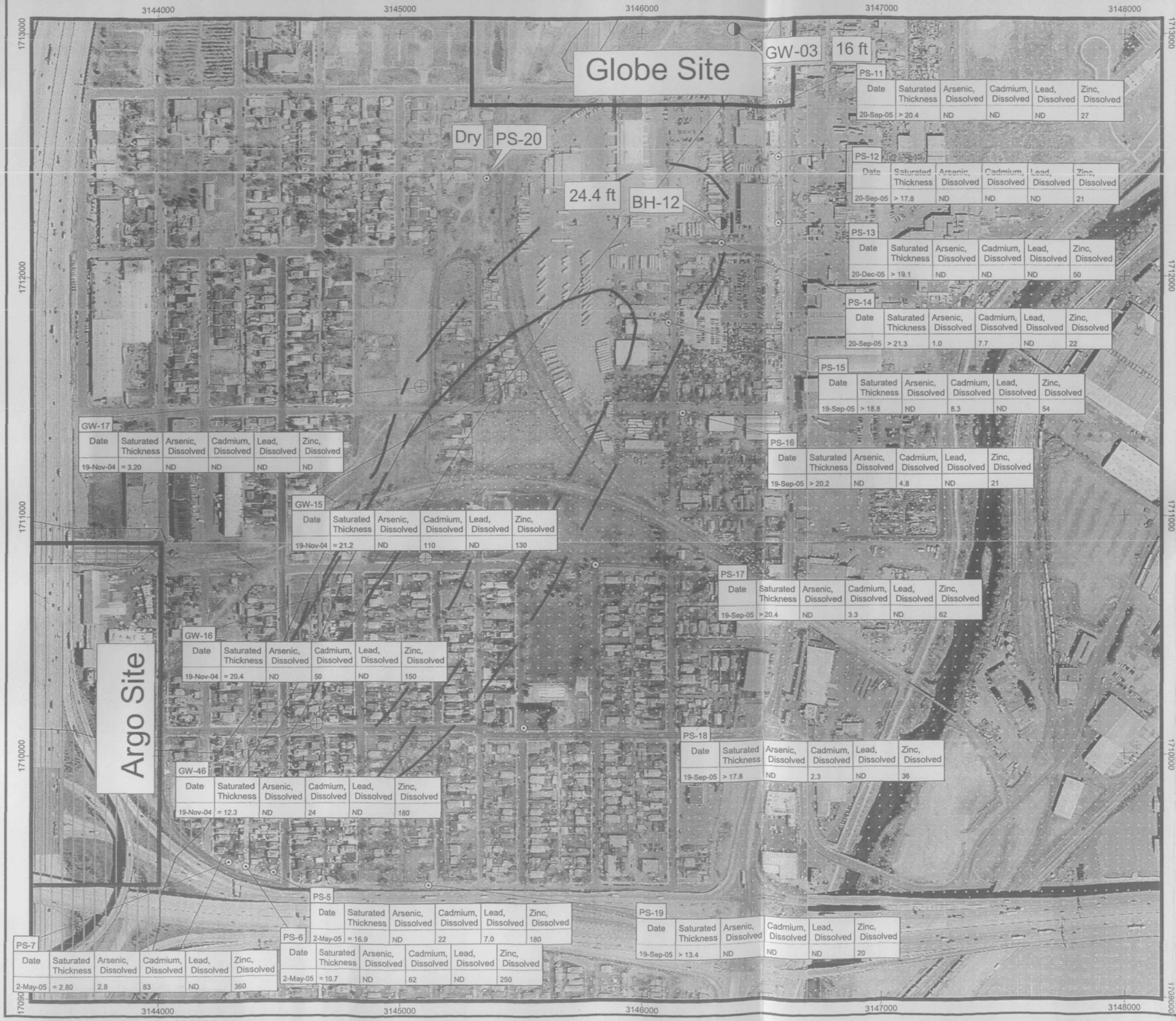


Figure 4-14. Nature and Extent of Groundwater Contamination
Mean Concentration of Dissolved Metals (ug/L)





Source: Knight Piésold 2006

LEGEND

- Argo and Globe Site Boundaries
- Platte Valley Alluvium
- Bedrock Outcrop

Globe RI Plumes (TRC, 1988)

- Cadmium (10 ppb)
- Zinc (10 and 100 ppb)

Globe Site Monitoring Wells

- Active
- Unkwn

Recent Geoprobe Sample Locations

- Aug., 2005
- May, 2005

Notes:

1) Projection: Colorado state plane, central zone, NAD83.
2) Saturated Thicknesses in feet.
3) Concentrations in ug/L.

Figure 4-16. Location of Off-Site Wells and the Platte River Valley Alluvium

N

200 0 200 400 Feet

Knight Piésold CONSULTING

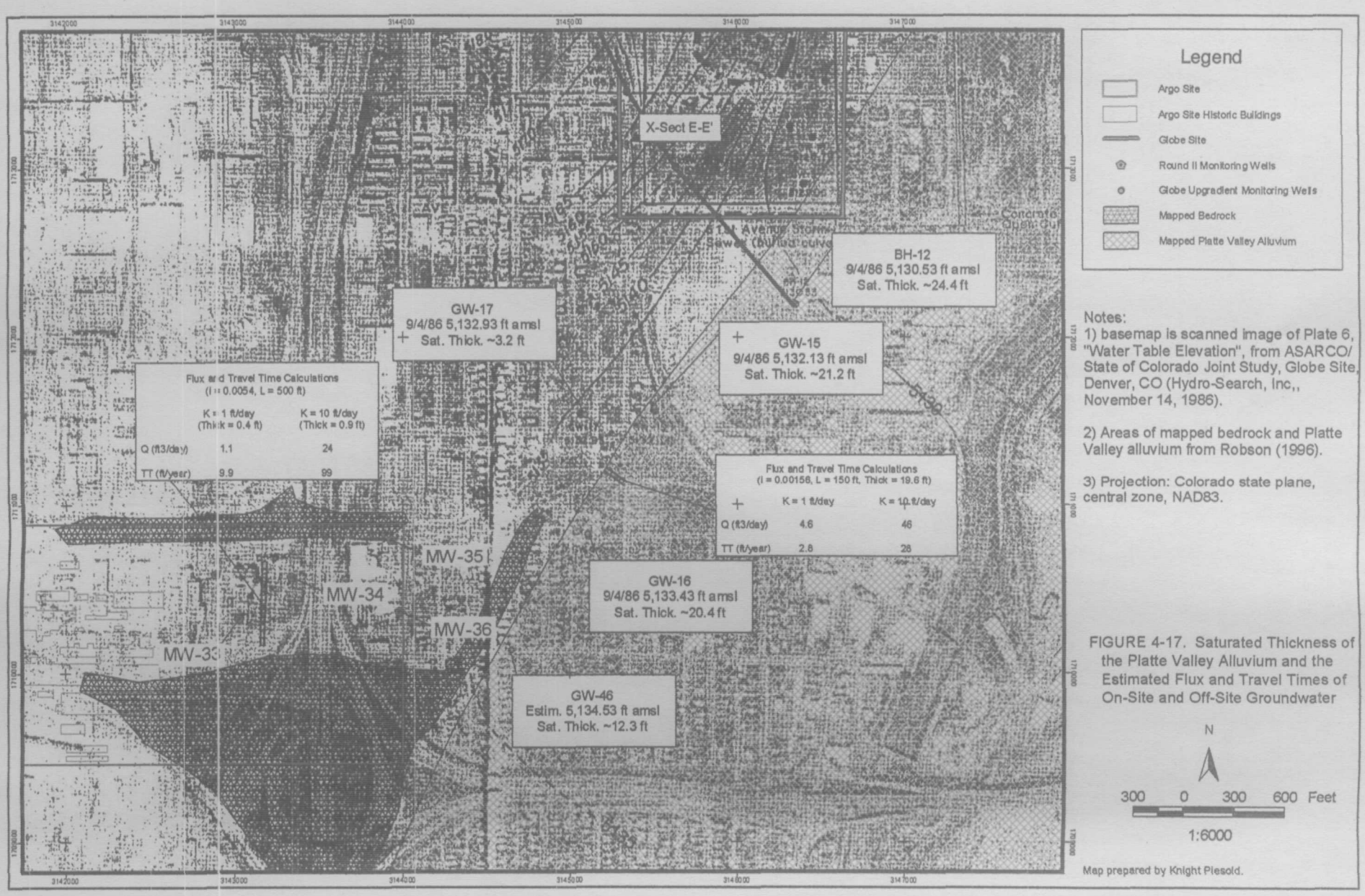
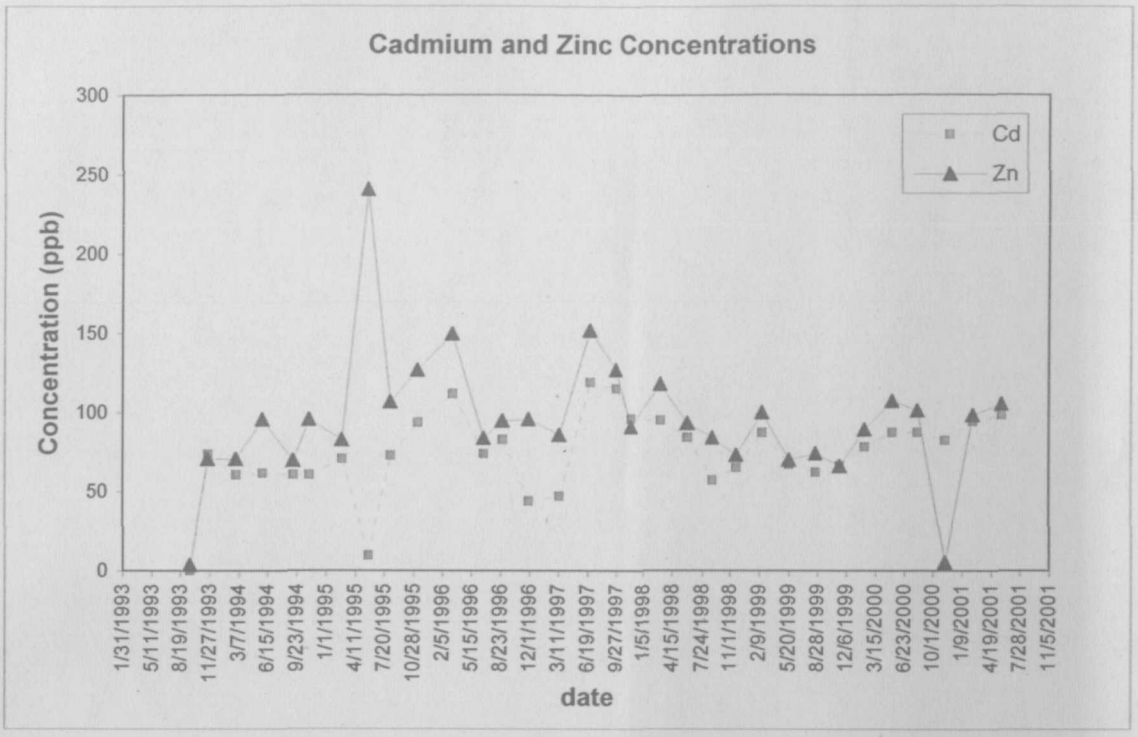


FIGURE 4-17. Saturated Thickness of the Platte Valley Alluvium and the Estimated Flux and Travel Times of On-Site and Off-Site Groundwater

Figure 4-18 Temporal Variation in Cadmium and Zinc Concentrations 1993-2001
GW-15



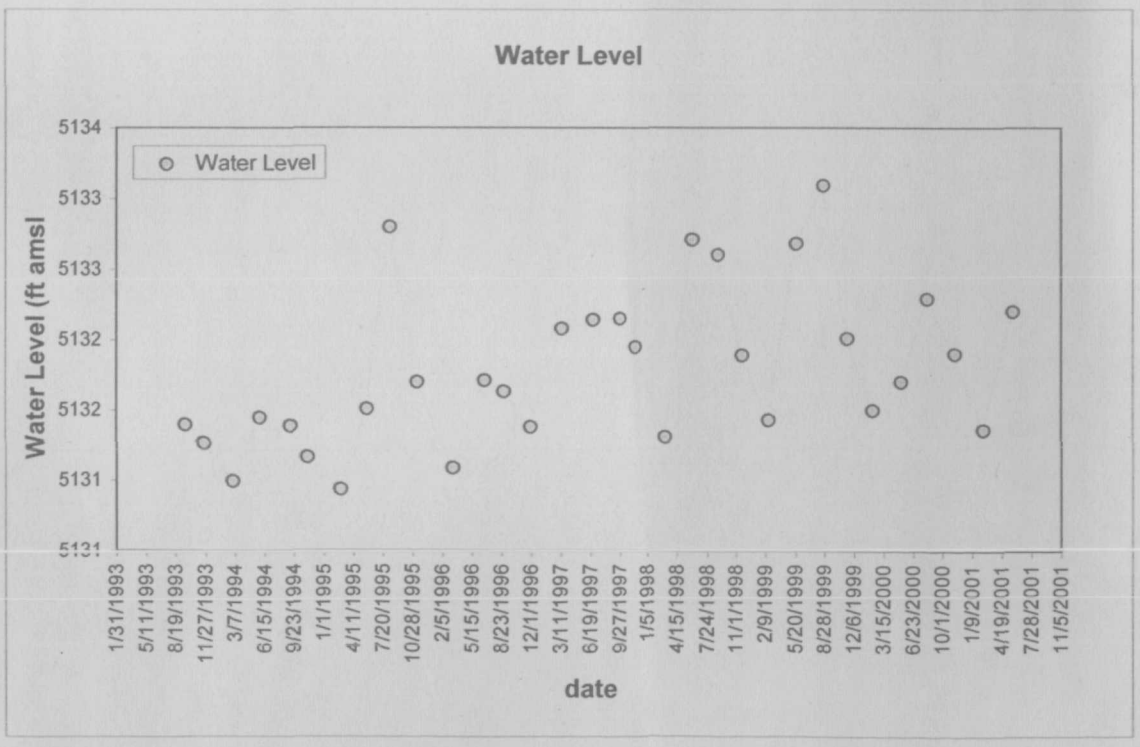
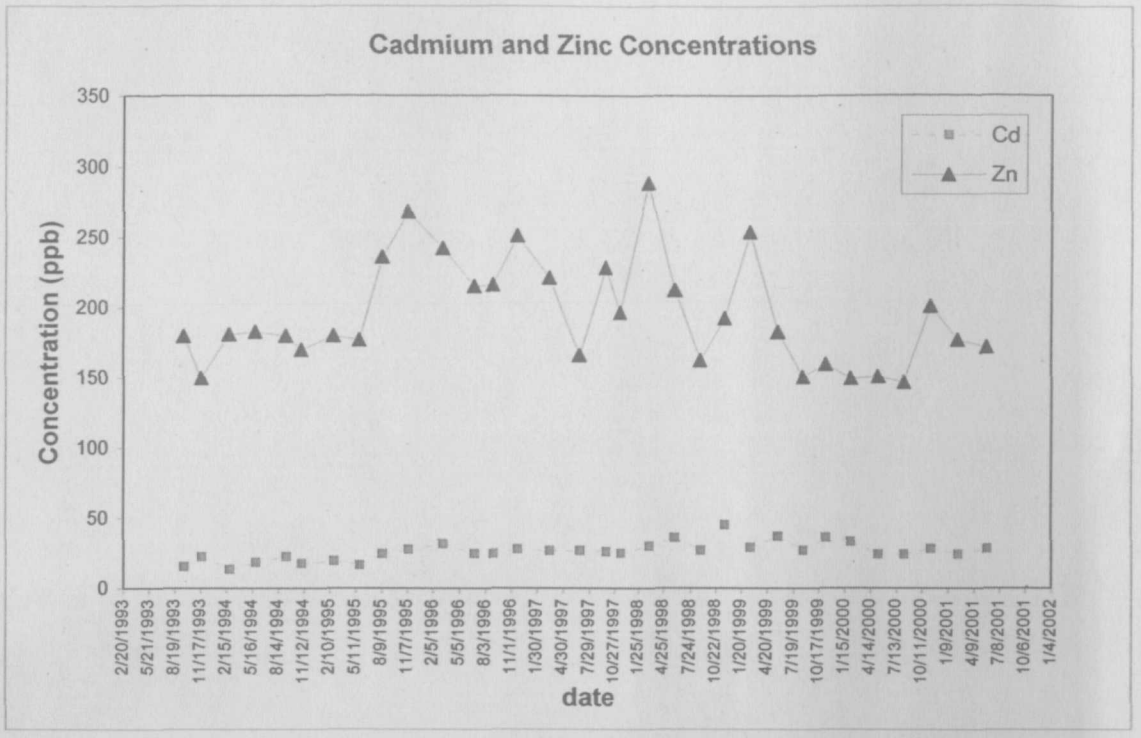
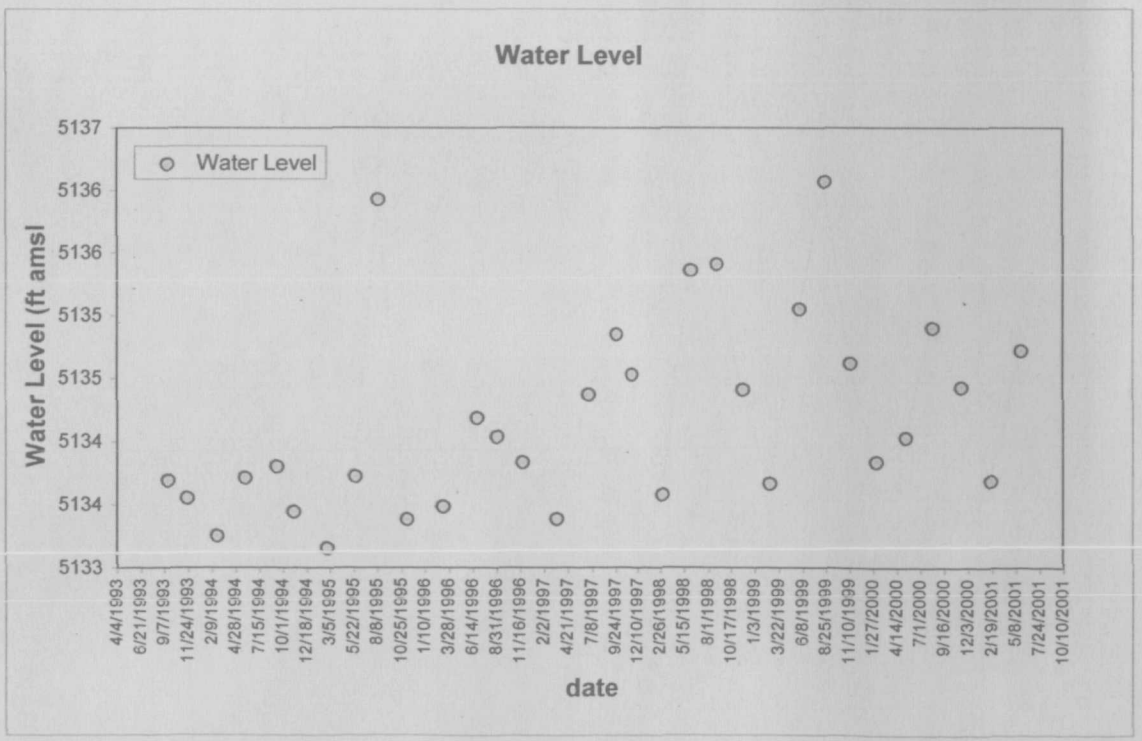
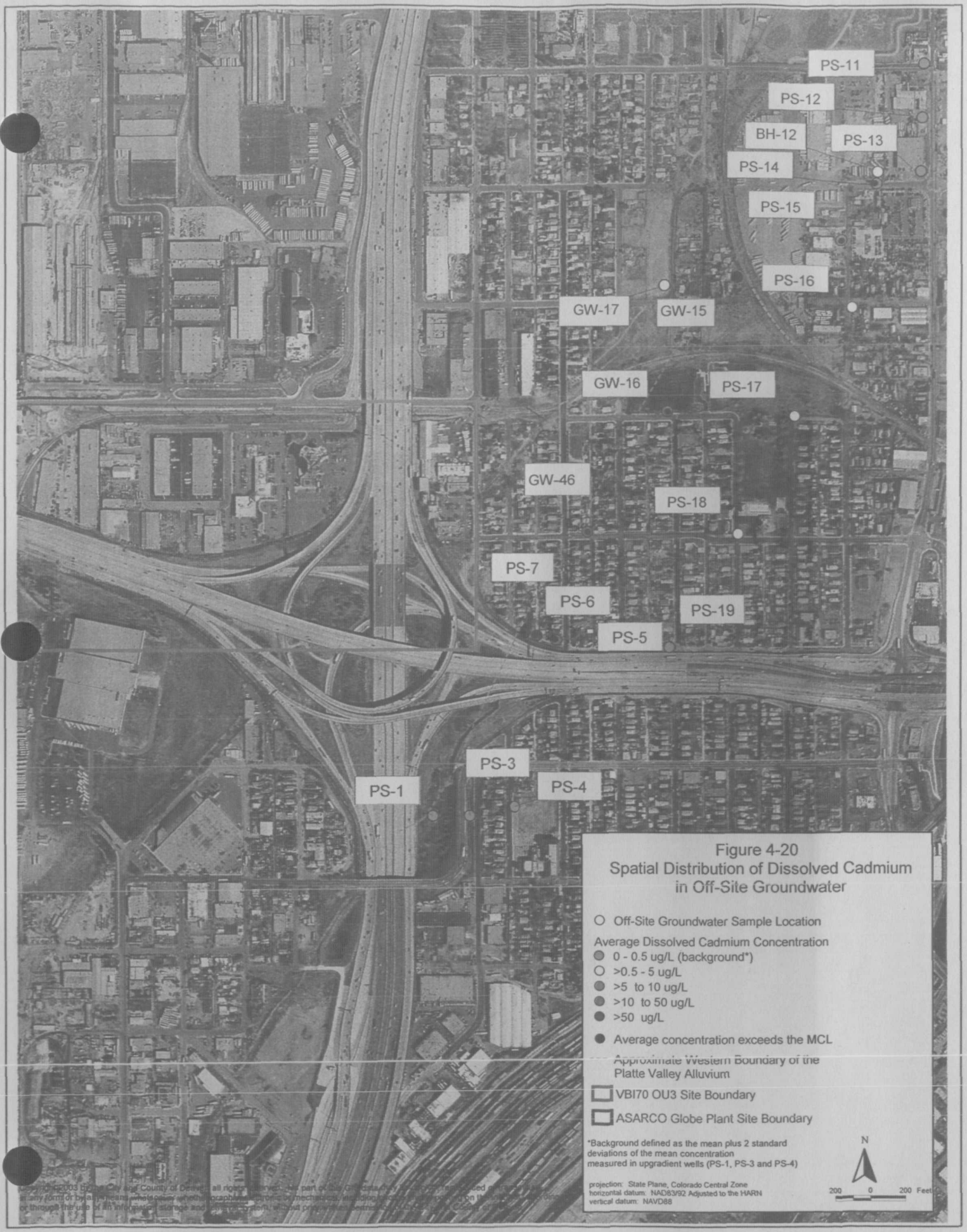


Figure 4-19 Temporal Variation in Cadmium and Zinc Concentrations 1993 - 2001
GW-46






PS-11
PS-12
BH-12
PS-13
PS-14
PS-15
PS-16
GW-17
GW-15
GW-16
PS-17
GW-46
PS-18
PS-7
PS-6
PS-19
PS-5
PS-3
PS-1
PS-4
Figure 4-20
Spatial Distribution of Dissolved Cadmium in Off-Site Groundwater
Off-Site Groundwater Sample Location
Average Dissolved Cadmium Concentration
0 - 0.5 ug/L (background*)
>0.5 - 5 ug/L
>5 to 10 ug/L
>10 to 50 ug/L
>50 ug/L
Average concentration exceeds the MCL
Approximate Western Boundary of the Platte Valley Alluvium
VBI70 OU3 Site Boundary
ASARCO Globe Plant Site Boundary
*Background defined as the mean plus 2 standard deviations of the mean concentration measured in upgradient wells (PS-1, PS-3 and PS-4)
projection: State Plane, Colorado Central Zone
horizontal datum: NAD83/92 Adjusted to the HARN
vertical datum: NAVD88
N
200 0 200 Feet

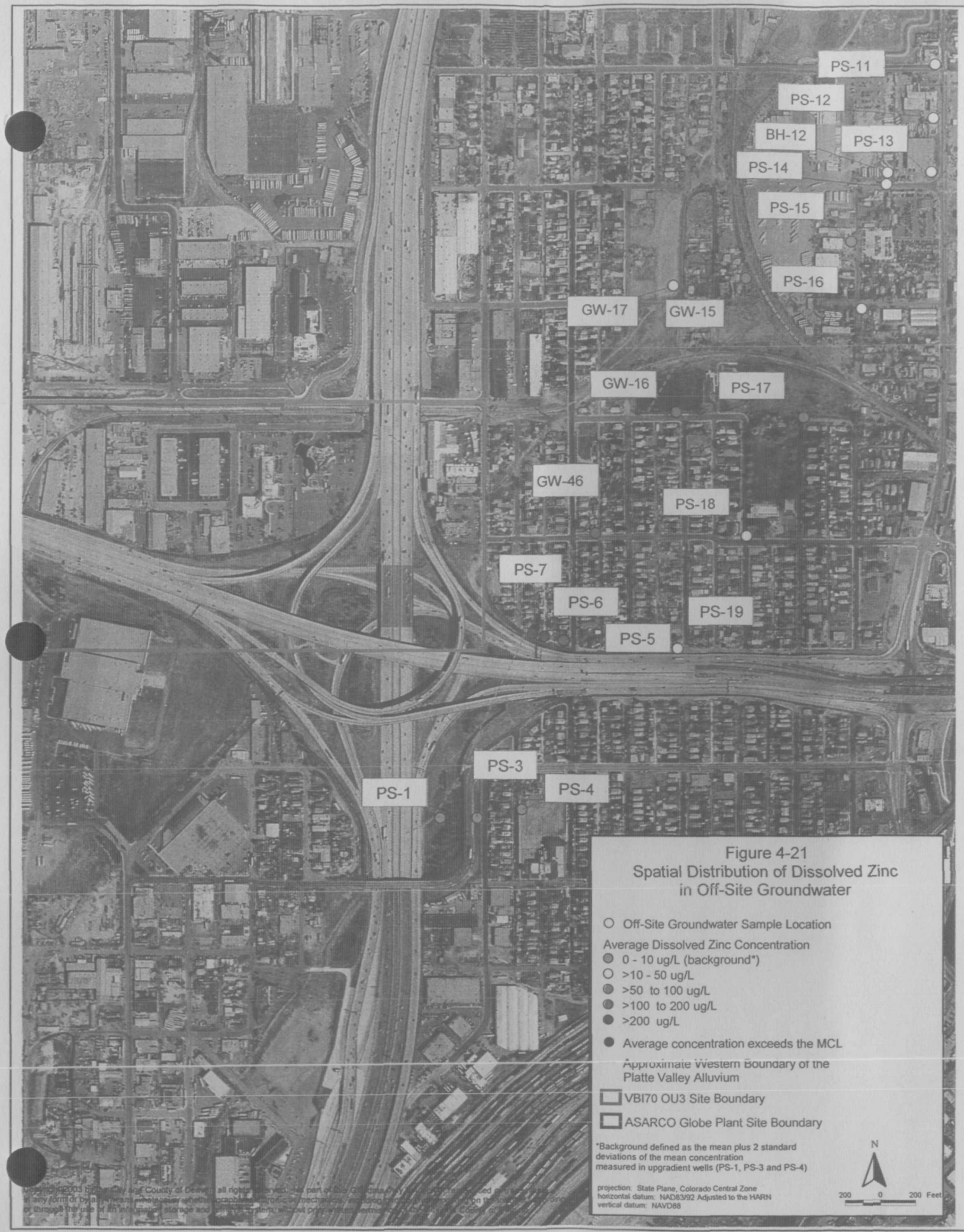


Figure 4-21
Spatial Distribution of Dissolved Zinc in Off-Site Groundwater

- Off-Site Groundwater Sample Location

Average Dissolved Zinc Concentration

- 0 - 10 ug/L (background*)
- >10 - 50 ug/L
- >50 to 100 ug/L
- >100 to 200 ug/L
- >200 ug/L

- Average concentration exceeds the MCL
- Approximate Western Boundary of the Platte Valley Alluvium
- VBI70 OU3 Site Boundary
- ASARCO Globe Plant Site Boundary

*Background defined as the mean plus 2 standard deviations of the mean concentration measured in upgradient wells (PS-1, PS-3 and PS-4)

projection: State Plane, Colorado Central Zone
horizontal datum: NAD83/92 Adjusted to the HARN
vertical datum: NAVD88

N

200 0 200 Feet

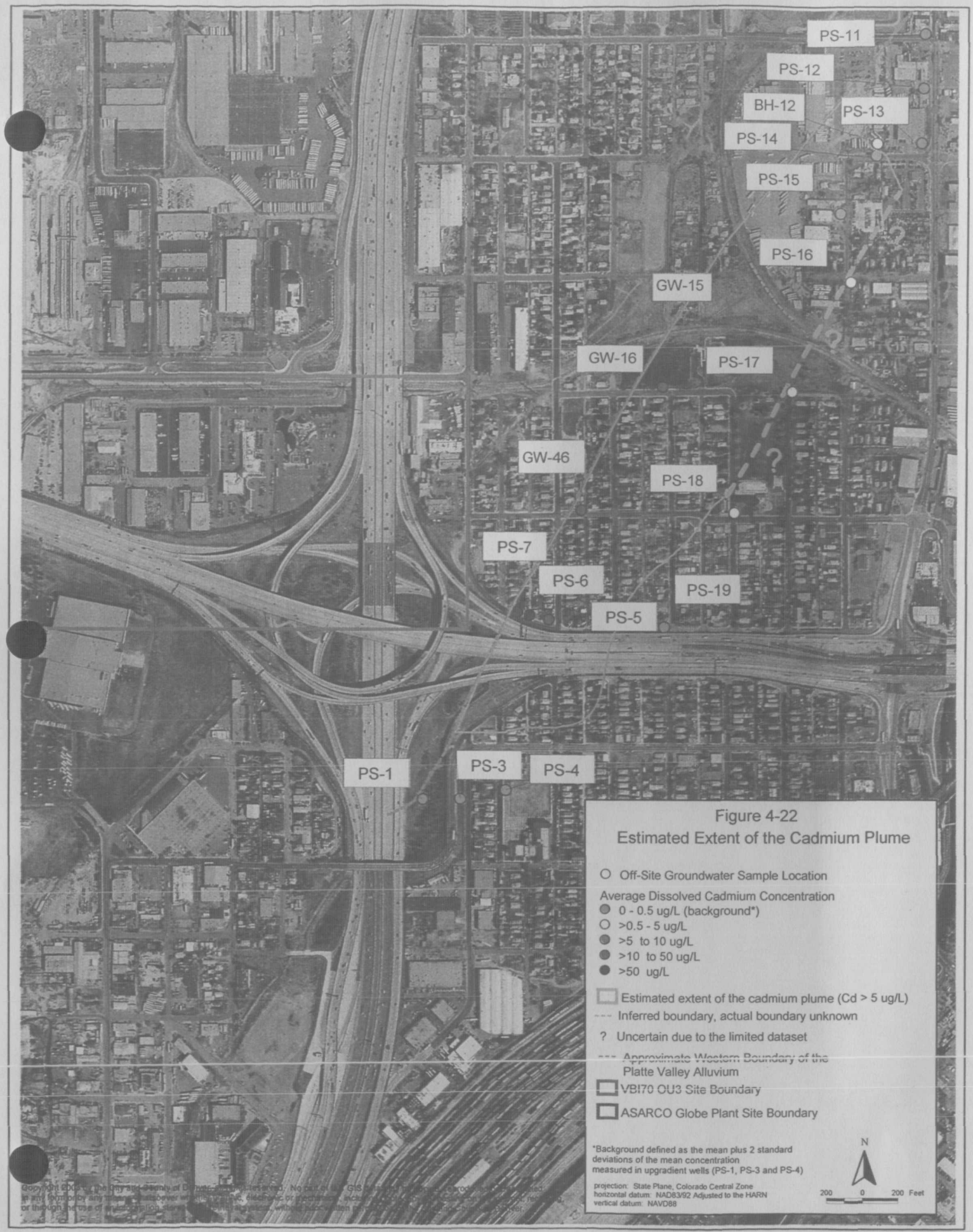
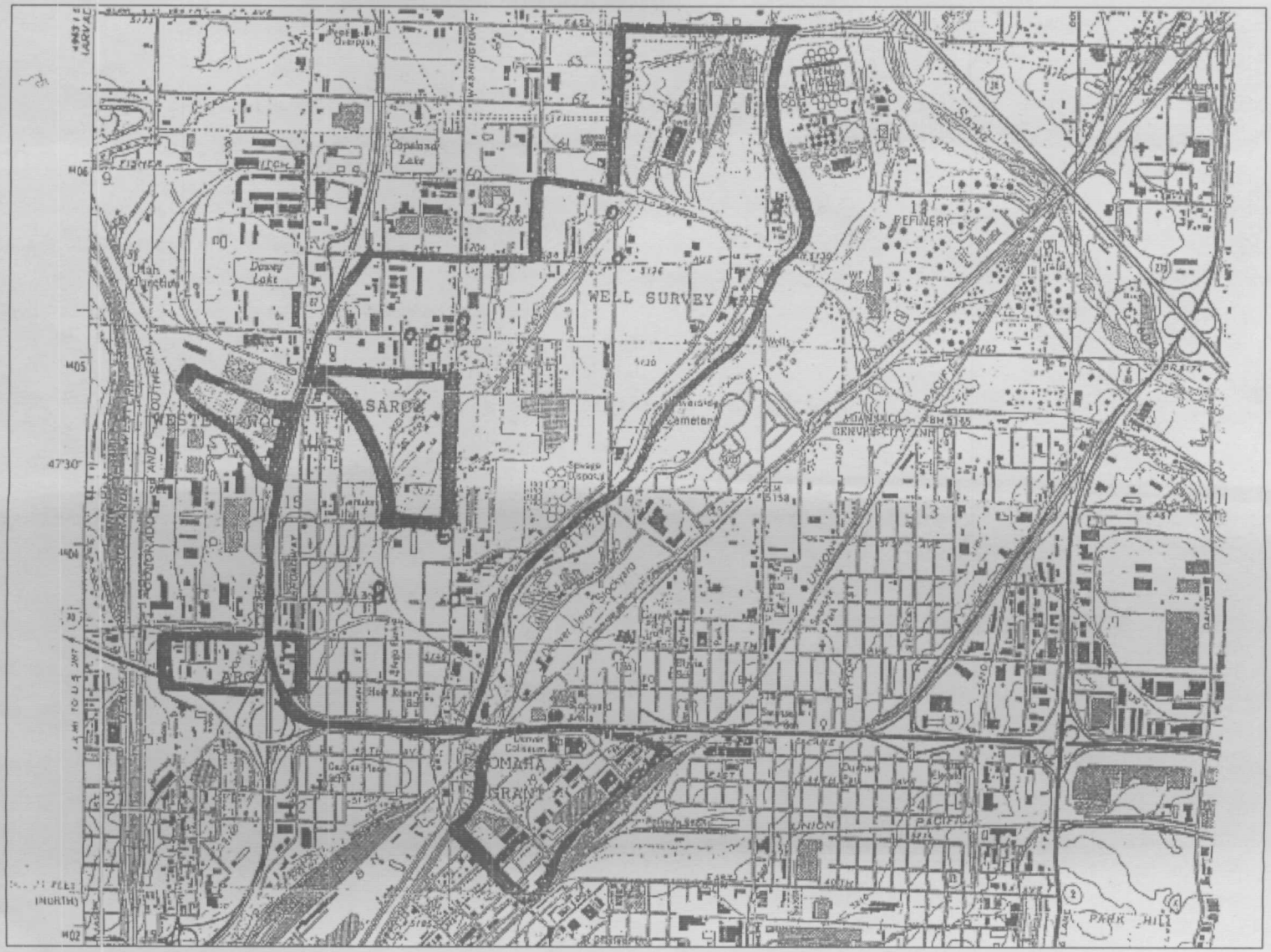

PS-11
PS-12
BH-12
PS-13
PS-14
PS-15
PS-16
GW-15
GW-16
PS-17
GW-46
PS-18
PS-7
PS-6
PS-19
PS-5
PS-1
PS-3
PS-4
Figure 4-22
Estimated Extent of the Cadmium Plume
Off-Site Groundwater Sample Location
Average Dissolved Cadmium Concentration
0 - 0.5 ug/L (background*)
>0.5 - 5 ug/L
>5 to 10 ug/L
>10 to 50 ug/L
>50 ug/L
Estimated extent of the cadmium plume (Cd > 5 ug/L)
Inferred boundary, actual boundary unknown
? Uncertain due to the limited dataset
Approximate Western Boundary of the Platte Valley Alluvium
VB170 OU3 Site Boundary
ASARCO Globe Plant Site Boundary
*Background defined as the mean plus 2 standard deviations of the mean concentration measured in upgradient wells (PS-1, PS-3 and PS-4)
projection: State Plane, Colorado Central Zone
horizontal datum: NAD83/92 Adjusted to the HARN
vertical datum: NAVD88
N
200 0 200 Feet


Figure 4-23
Wells in the Vicinity of the VBI70 OU3 Site
Division of Water Resources Well Data (2007)
Colorado Department of Health Well Survey Data (1992)
Street
VBI70 OU3 Site Boundary
Asarco Globe Plant Site
N
projection: State Plane, Colorado Central Zone
horizontal datum: NAD83/92 Adjusted to the HARN
vertical datum: NAVD88
500 0 500 1000 Feet

Figure 4-24
Colorado Department of Health 1992 Well Survey Study Area



Source: CDH 1992

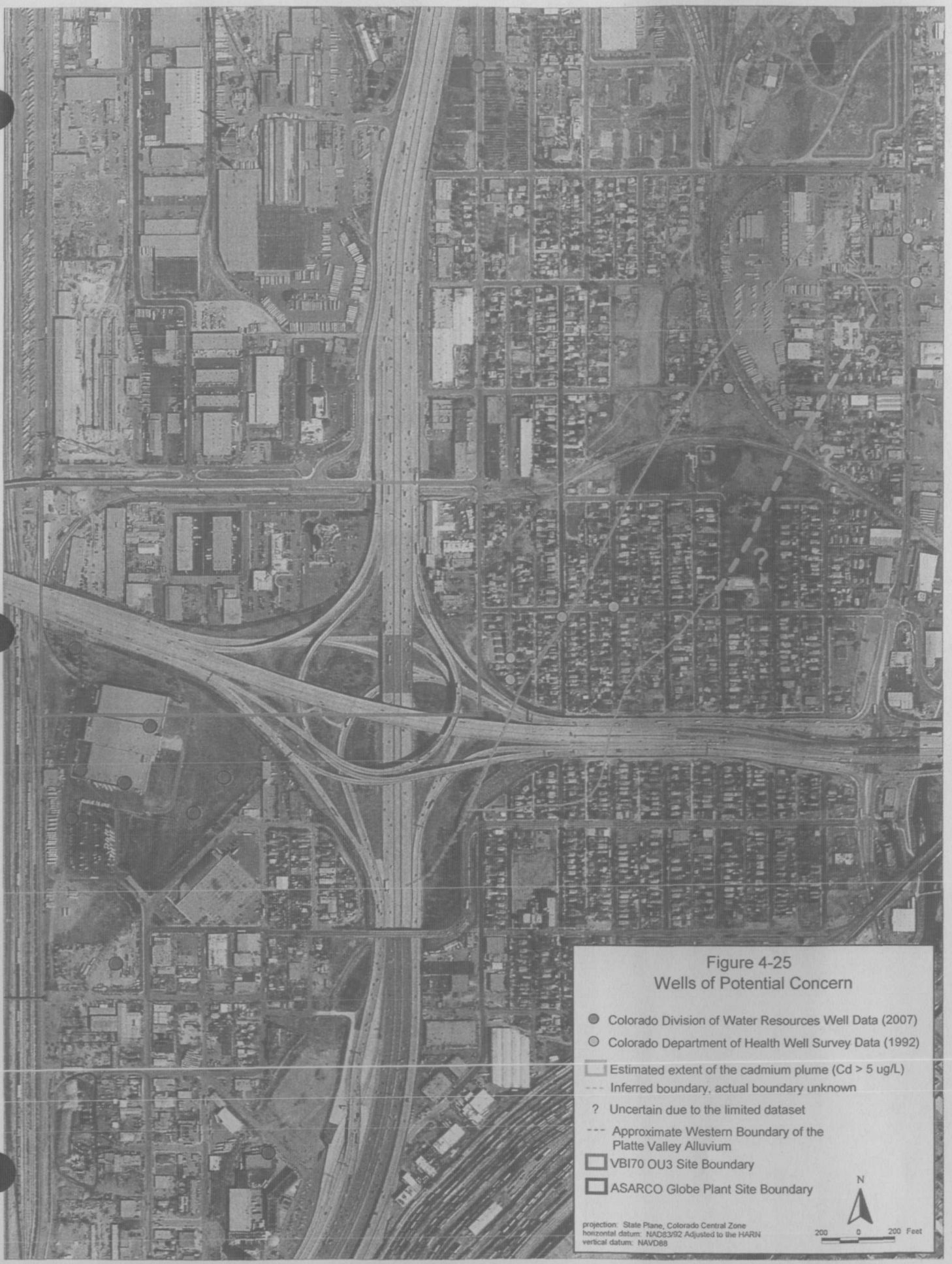
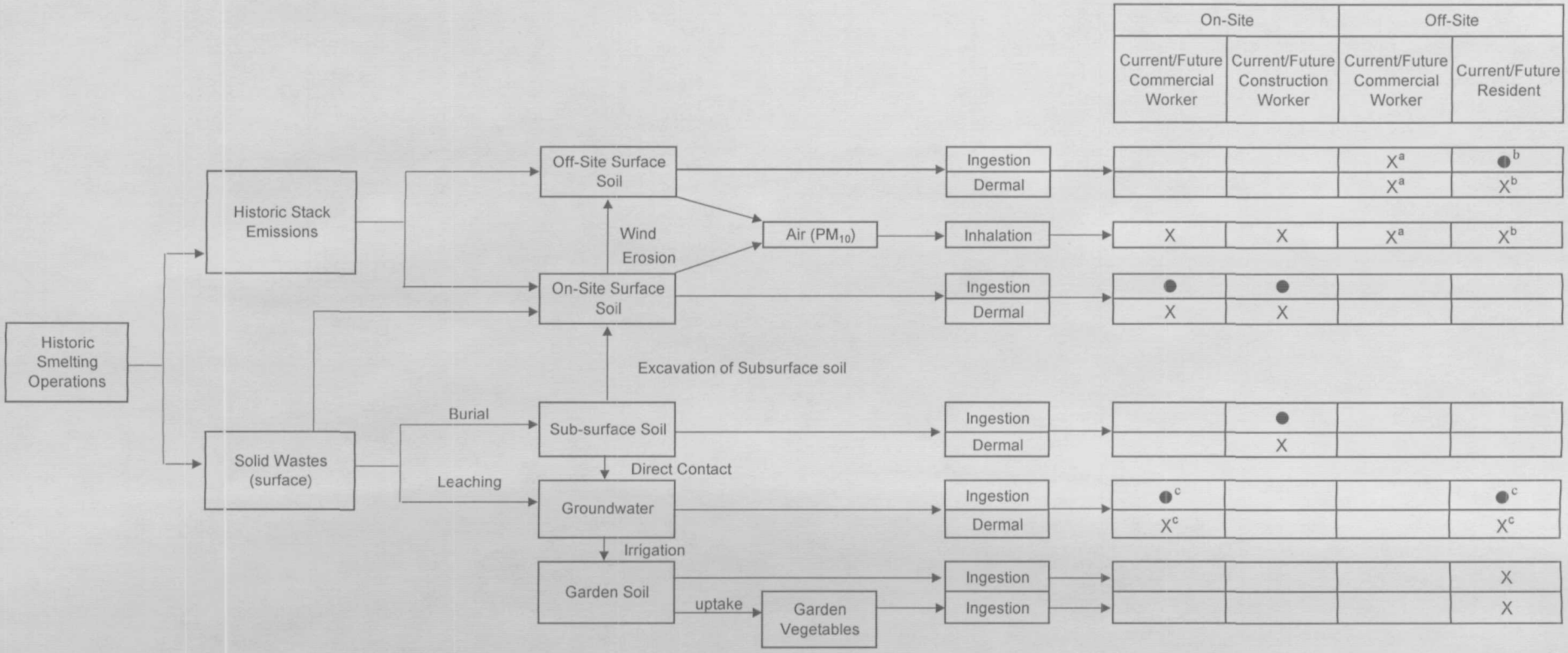


Figure 4-25
Wells of Potential Concern
Colorado Division of Water Resources Well Data (2007)
Colorado Department of Health Well Survey Data (1992)
Estimated extent of the cadmium plume (Cd > 5 ug/L)
Inferred boundary, actual boundary unknown
? Uncertain due to the limited dataset
Approximate Western Boundary of the Platte Valley Alluvium
VBI70 OU3 Site Boundary
ASARCO Globe Plant Site Boundary
N
projection: State Plane, Colorado Central Zone
horizontal datum: NAD83/92 Adjusted to the HARN
vertical datum: NAVD88
200 0 200 Feet

Figure 6-1. Site Conceptual Model for Human Exposure



LEGEND

	Pathway is not complete; no evaluation required
X	Pathway is or might be complete, but is judged to be minor; qualitative evaluation
●	Pathway is or might be complete and might be significant; sufficient data are available for quantitative evaluation

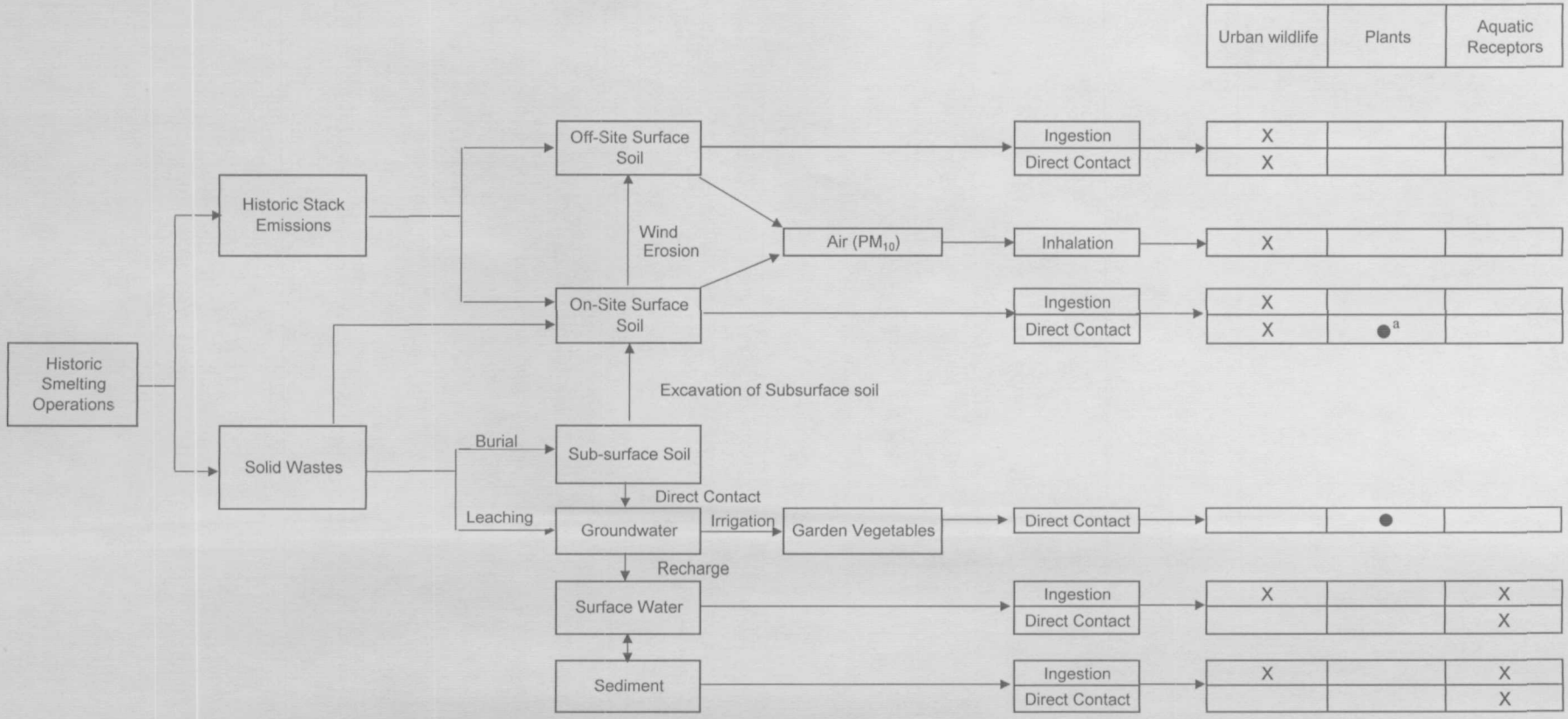
Notes:

a While this is a potentially a complete pathway, the impacts (if any) of operations at the ARGO Smelter on off-site soils have been evaluated in the areas of likely off-site release (to the northeast and south) using data from previous investigations (SRC, 2001 and TRC, 1988). Based on the levels of contaminants present in surface soils in these off-site locations (USEPA, 2003b; Table 3-1), this pathway is not likely to be of concern to commercial workers.

b While this exposure pathway is complete and might be significant, residential exposures to smelter related emissions in surface soil have already been evaluated in areas east (TRC, 1988) and south (SRC, 2001) of the site. Thus, this pathway is not evaluated quantitatively in this risk assessment.

c Currently, this exposure pathway is incomplete; however, future hypothetical exposures will be evaluated.

Figure 6-2. Site Conceptual Model for Ecological Exposure

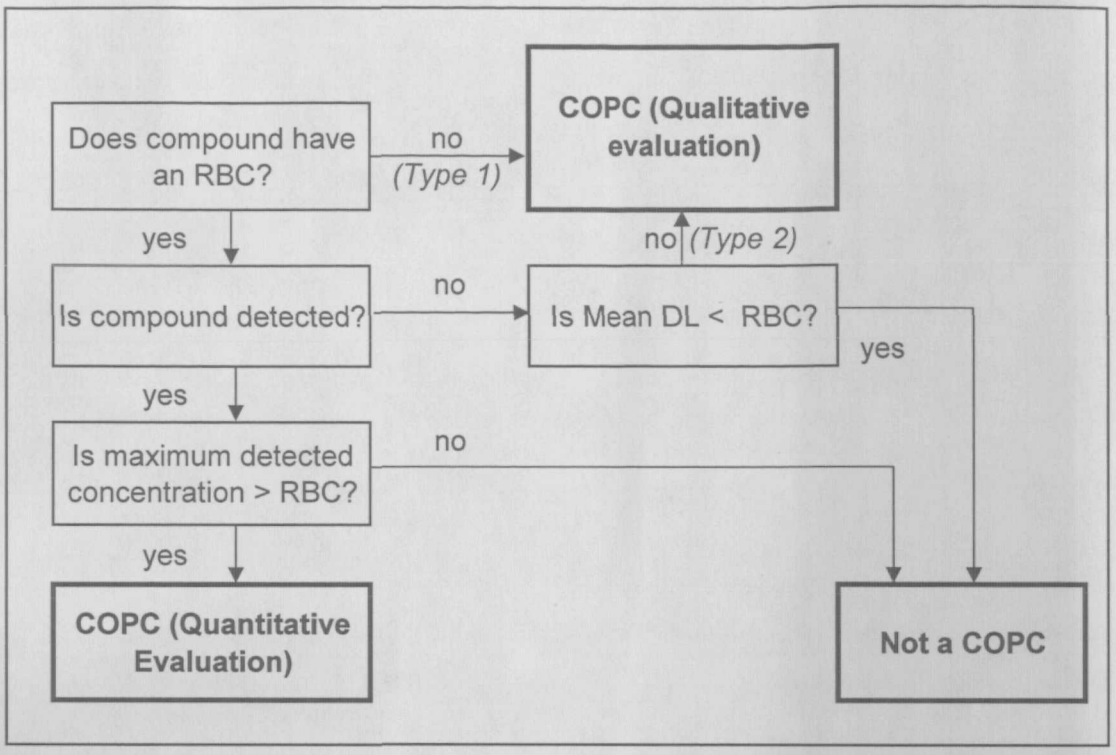


LEGEND

	Pathway is not complete; no evaluation required
X	Pathway is or might be complete, but is judged to be minor; qualitative evaluation
●	Pathway is or might be complete and might be significant; sufficient data are available for quantitative evaluation

a Currently, this exposure pathway is incomplete; however, future hypothetical exposures to subsurface soils that are exposed and brought to the surface will be evaluated.

Figure 6-3 COPC Selection Procedure



Notes:

RBC = Risk-based concentration (HQ = 0.1, Cancer risk = 1E-06)
COPC = chemical of potential concern
DL = Detection Limit

Figure 6-4. Estimated RME Non-cancer Hazard Index (HI) for Commercial Workers from Ingestion of Soil

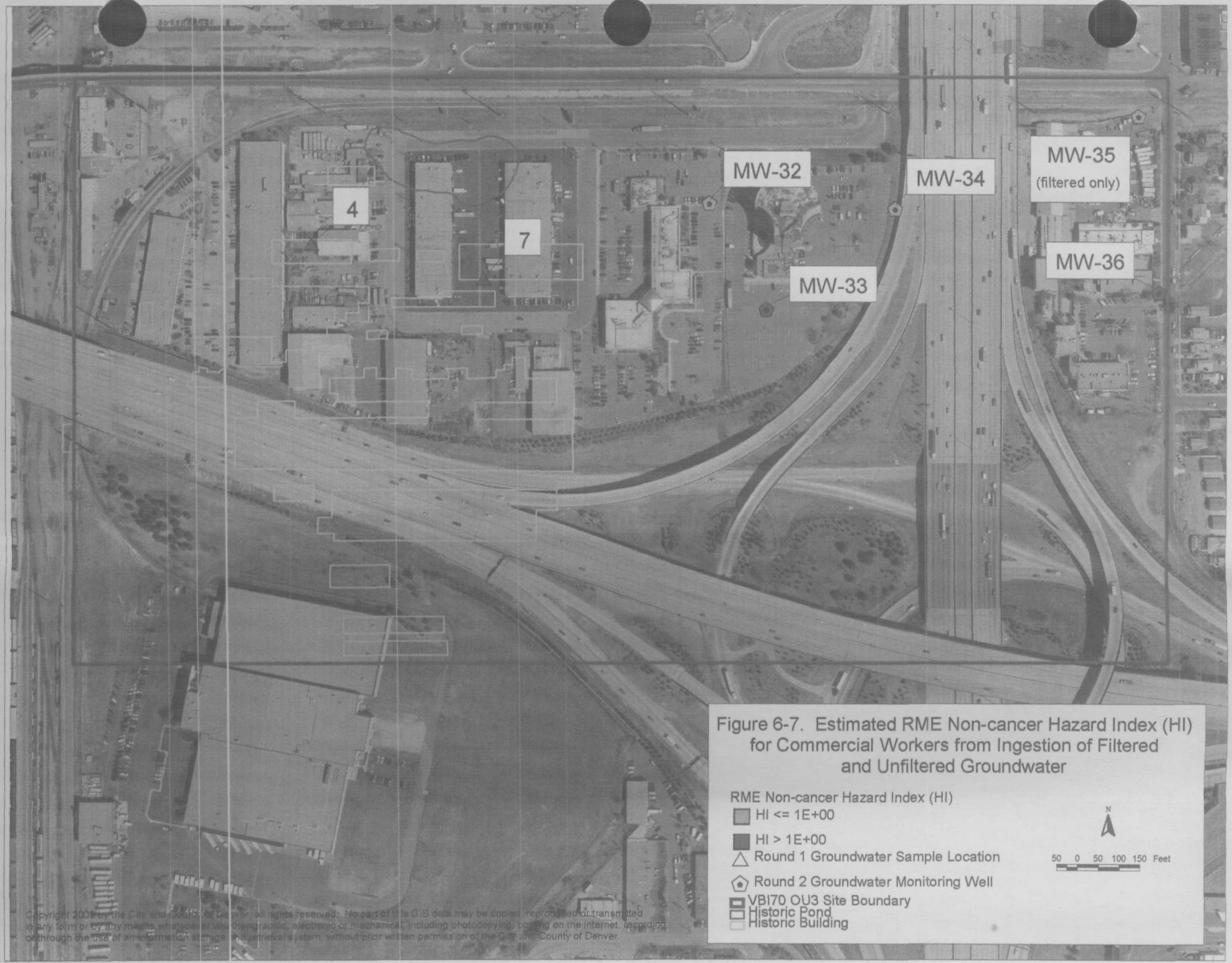


Figure 6-7. Estimated RME Non-cancer Hazard Index (HI) for Commercial Workers from Ingestion of Filtered and Unfiltered Groundwater

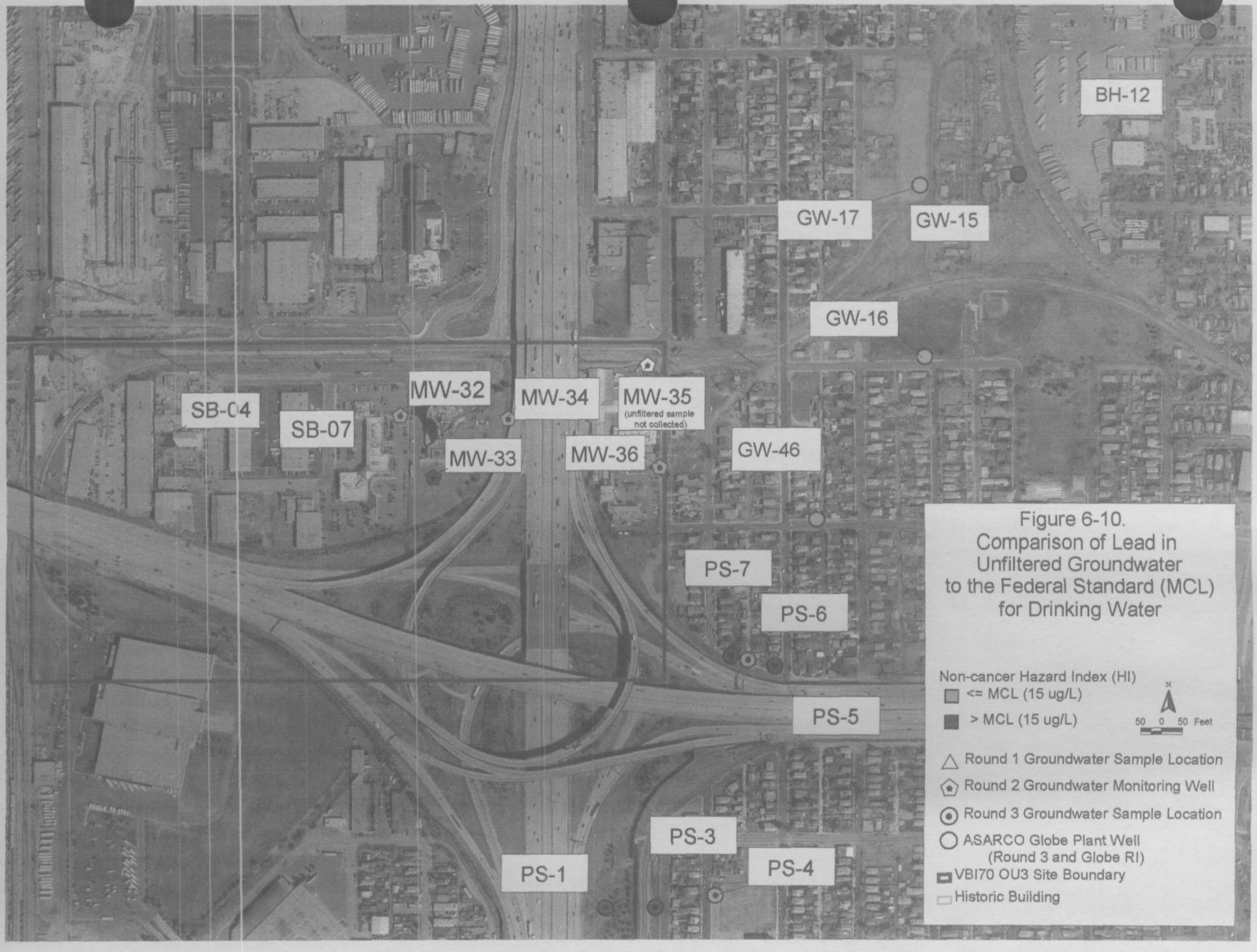
Table 6-8. Estimated RME Cancer Risks for Commercial Workers from Ingestion of Filtered Groundwater

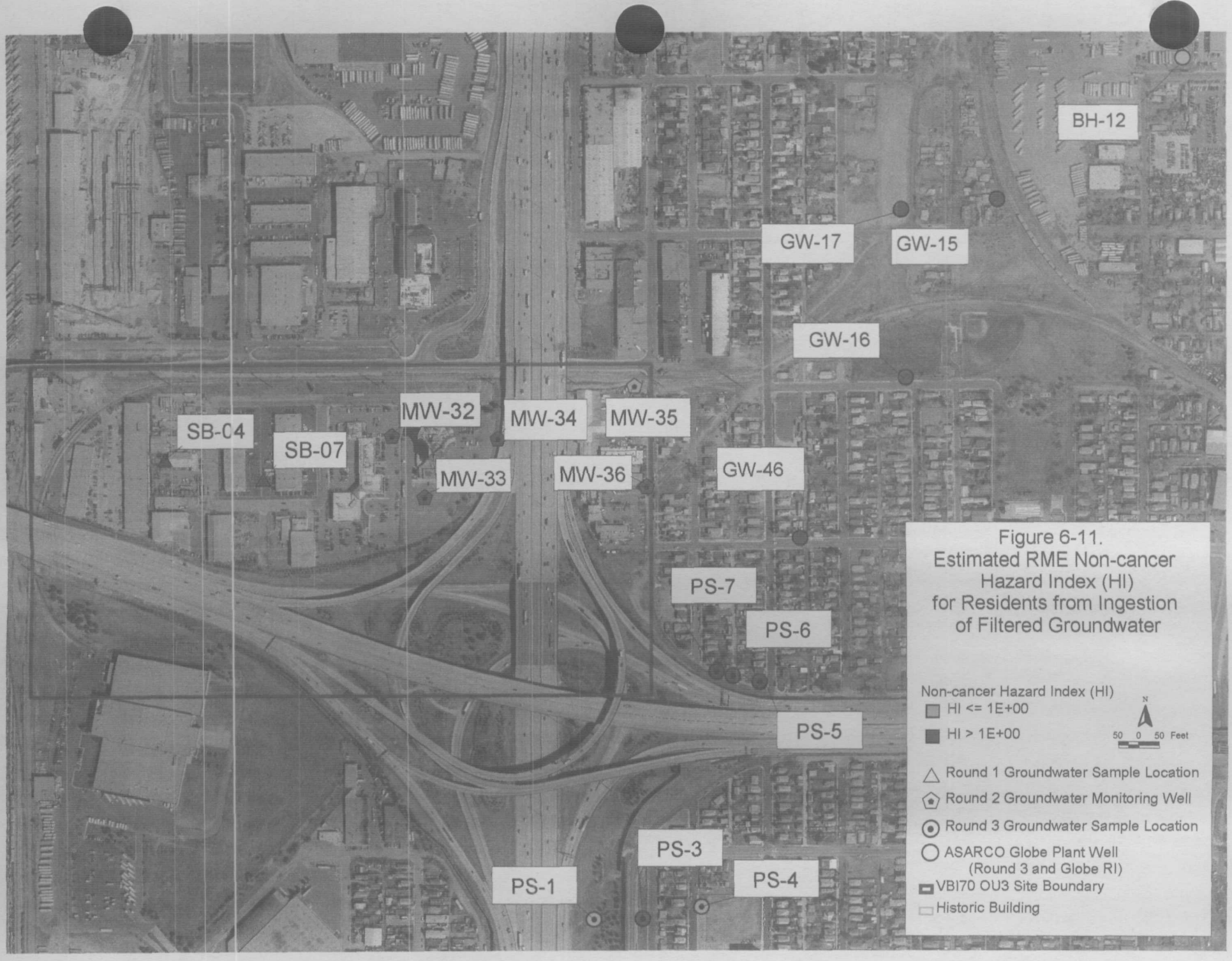
RME Cancer Risk Estimate
- <=1E-06
- > 1E-06 to <=1E-05
- > 1E-05 to <=1E-04
- > 1E-04

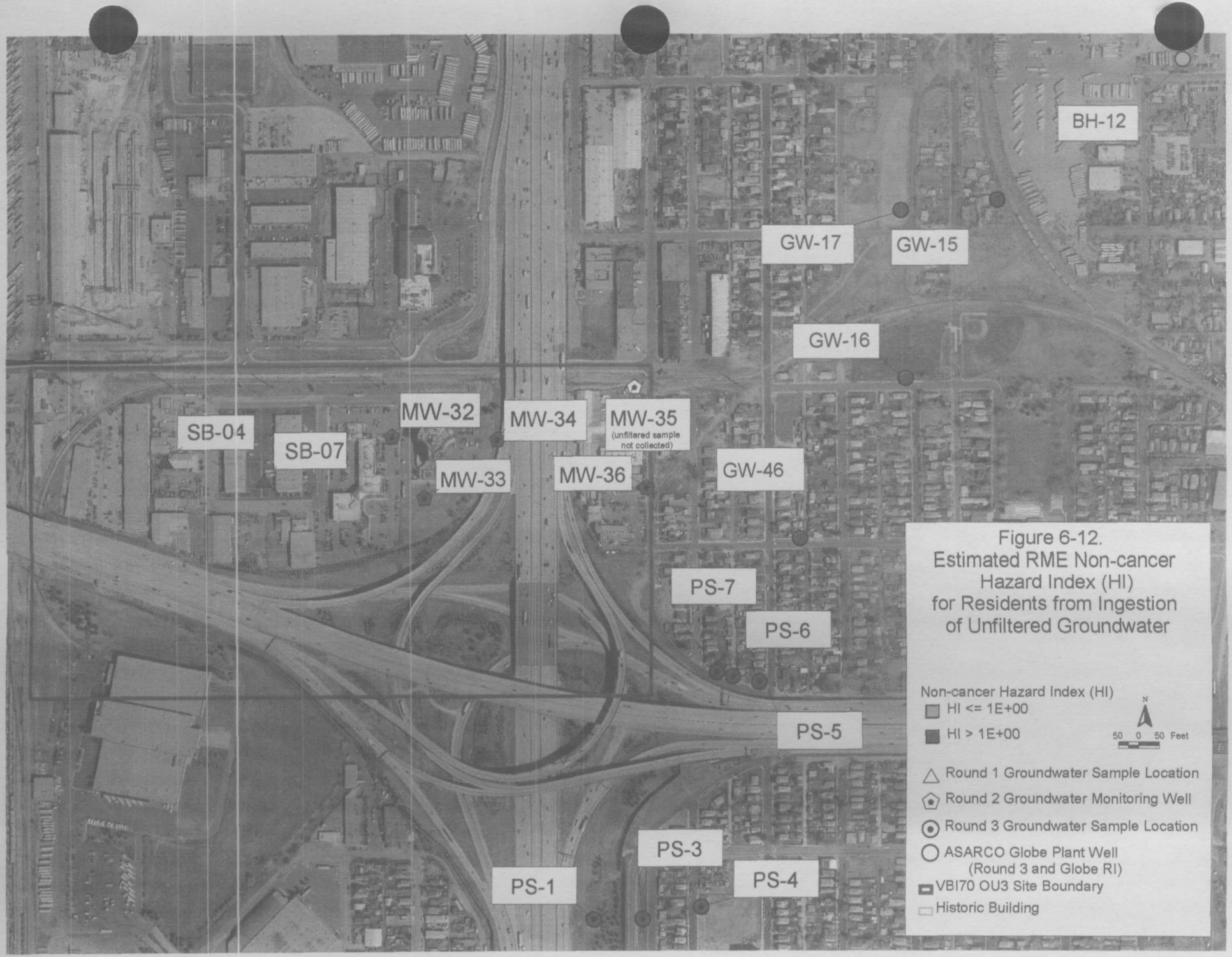
Round 1 Groundwater Sample Location
Round 2 Groundwater Monitoring Well
VBI70 OU3 Site Boundary
Historic Pond
Historic Building

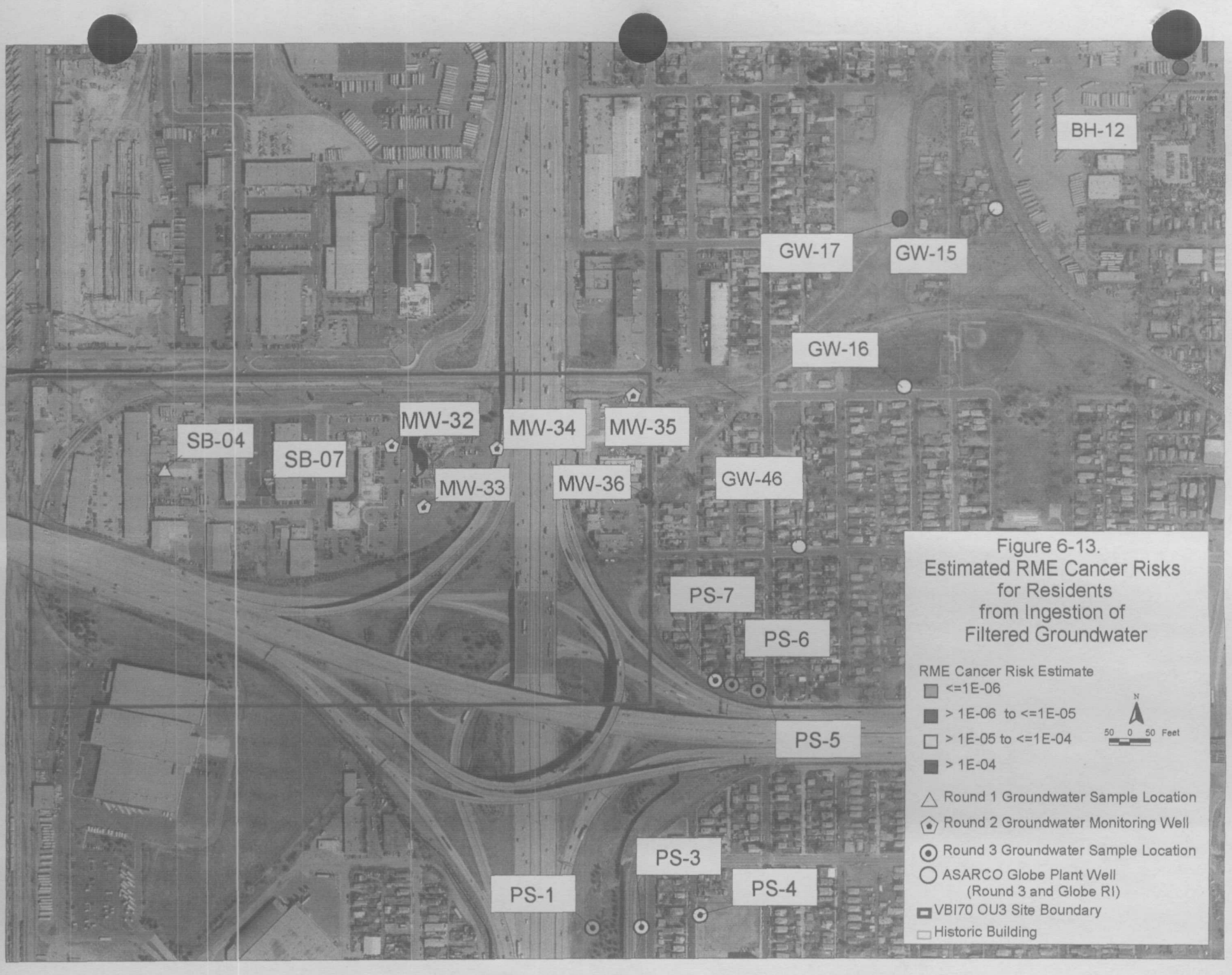
N

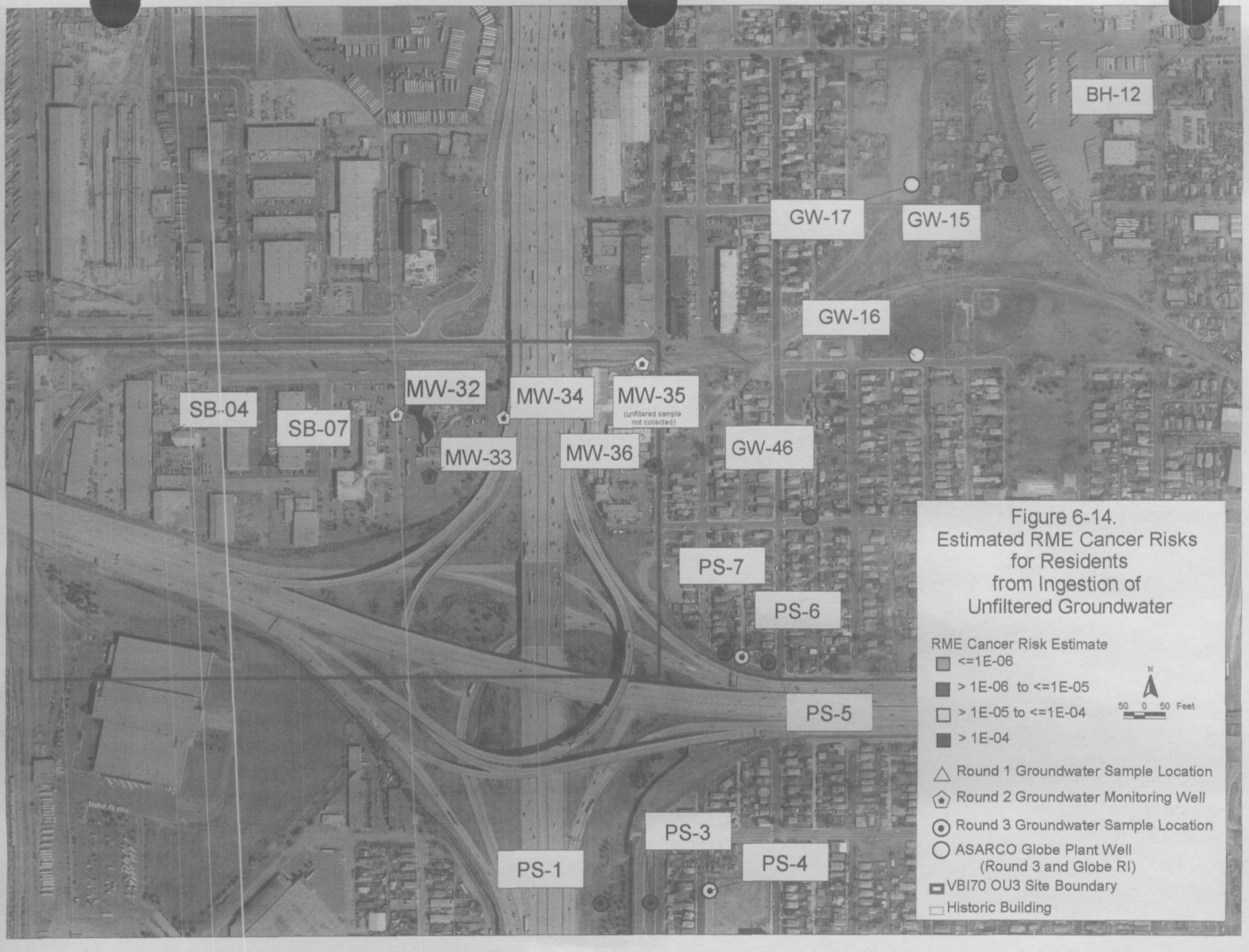
50 0 50 Feet


BH-12
GW-17
GW-15
GW-16
SB-04
SB-07
MW-32
MW-34
MW-35
(unfiltered sample not collected)
MW-33
MW-36
GW-46
PS-7
PS-6
PS-5
PS-3
PS-4
PS-1
Figure 6-10.
Comparison of Lead in
Unfiltered Groundwater
to the Federal Standard (MCL)
for Drinking Water
Non-cancer Hazard Index (HI)
<= MCL (15 ug/L)
> MCL (15 ug/L)
N
50 0 50 Feet
Round 1 Groundwater Sample Location
Round 2 Groundwater Monitoring Well
Round 3 Groundwater Sample Location
ASARCO Globe Plant Well
(Round 3 and Globe RI)
VBI70 OU3 Site Boundary
Historic Building


BH-12
GW-17
GW-15
GW-16
SB-04
SB-07
MW-32
MW-34
MW-35
MW-33
MW-36
GW-46
PS-7
PS-6
PS-5
PS-3
PS-4
PS-1
Figure 6-11.
Estimated RME Non-cancer
Hazard Index (HI)
for Residents from Ingestion
of Filtered Groundwater
Non-cancer Hazard Index (HI)
HI <= 1E+00
HI > 1E+00
N
50 0 50 Feet
Round 1 Groundwater Sample Location
Round 2 Groundwater Monitoring Well
Round 3 Groundwater Sample Location
ASARCO Globe Plant Well
(Round 3 and Globe RI)
VBI70 OU3 Site Boundary
Historic Building


BH-12
GW-17
GW-15
GW-16
MW-32
MW-34
MW-35
(unfiltered sample not collected)
SB-04
SB-07
MW-33
MW-36
GW-46
PS-7
PS-6
PS-5
PS-3
PS-4
PS-1
Figure 6-12.
Estimated RME Non-cancer Hazard Index (HI) for Residents from Ingestion of Unfiltered Groundwater
Non-cancer Hazard Index (HI)
HI <= 1E+00
HI > 1E+00
N
50 0 50 Feet
Round 1 Groundwater Sample Location
Round 2 Groundwater Monitoring Well
Round 3 Groundwater Sample Location
ASARCO Globe Plant Well (Round 3 and Globe RI)
VBI70 OU3 Site Boundary
Historic Building


BH-12
GW-17
GW-15
GW-16
SB-04
SB-07
MW-32
MW-34
MW-35
MW-33
MW-36
GW-46
PS-7
PS-6
PS-5
PS-3
PS-4
PS-1
Figure 6-13.
Estimated RME Cancer Risks
for Residents
from Ingestion of
Filtered Groundwater
RME Cancer Risk Estimate
<=1E-06
> 1E-06 to <=1E-05
> 1E-05 to <=1E-04
> 1E-04
N
50 0 50 Feet
Round 1 Groundwater Sample Location
Round 2 Groundwater Monitoring Well
Round 3 Groundwater Sample Location
ASARCO Globe Plant Well
(Round 3 and Globe RI)
VBI70 OU3 Site Boundary
Historic Building


BH-12
GW-17
GW-15
GW-16
SB-04
SB-07
MW-32
MW-34
MW-35
(unfiltered sample not collected)
MW-33
MW-36
GW-46
PS-7
PS-6
PS-5
PS-3
PS-4
PS-1
Figure 6-14.
Estimated RME Cancer Risks
for Residents
from Ingestion of
Unfiltered Groundwater
RME Cancer Risk Estimate
<=1E-06
> 1E-06 to <=1E-05
> 1E-05 to <=1E-04
> 1E-04
N
50 0 50 Feet
Round 1 Groundwater Sample Location
Round 2 Groundwater Monitoring Well
Round 3 Groundwater Sample Location
ASARCO Globe Plant Well
(Round 3 and Globe RI)
VBI70 OU3 Site Boundary
Historic Building

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 1058551

SITE NAME: VASQUEZ BLVD & I70

DOCUMENT DATE: 09-01-2007

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☐ OVERSIZED
- ☑ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED
  (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

CD CONTAINING APPENDIX E - WELL DATA
qry_Zip_80216.xls

Contact the Superfund Records Center to view available document.
(303) 312-6473